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POWER

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POWER TOPICS CROSS-INDEX

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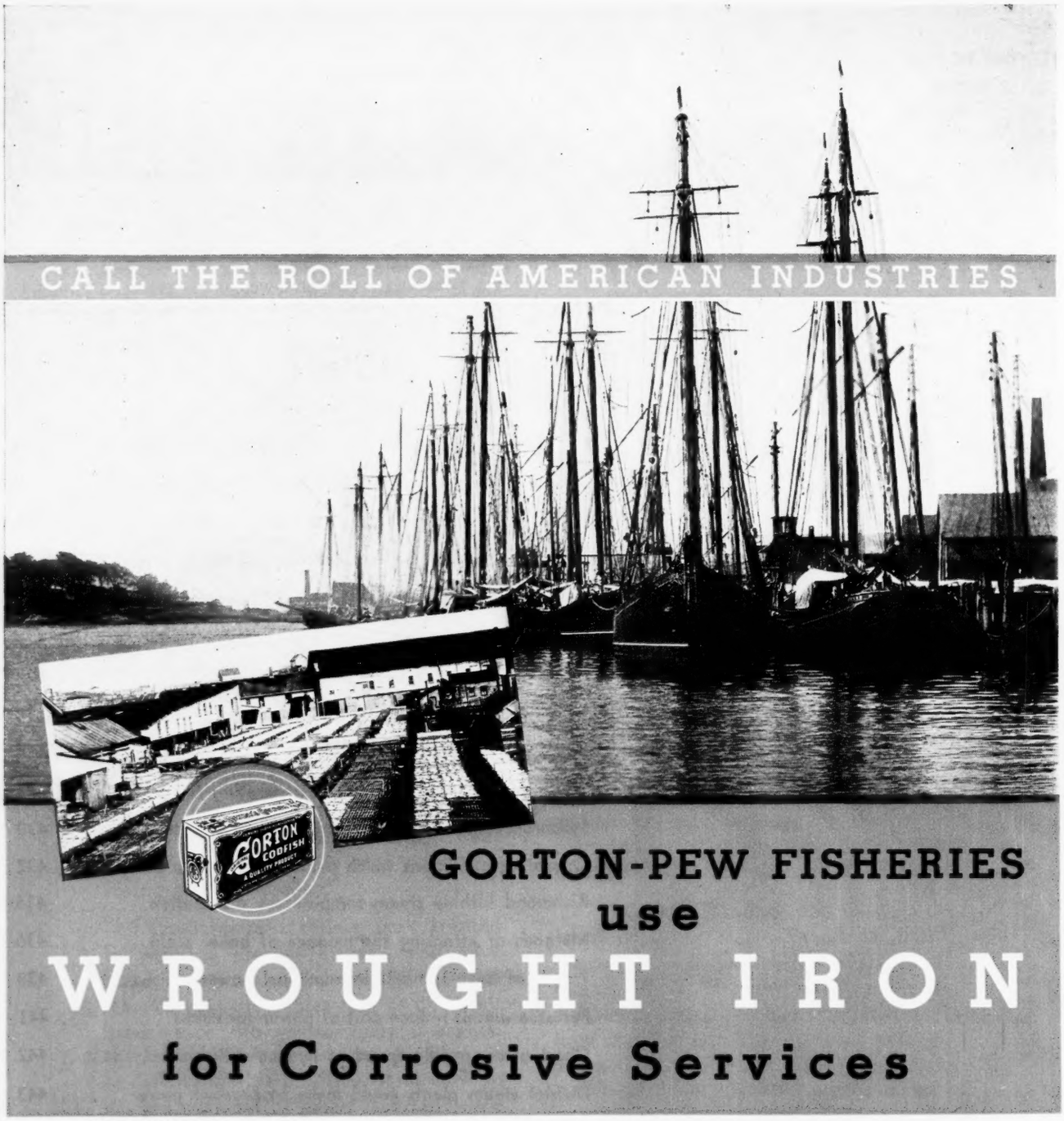

● Many industries require pipe material that will withstand severe corrosion. Which material will last longer and be more economical, is best determined by experience.

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POWER

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PHILIP W. SWAIN, Editor

WELCOME TO AMERICA

AMERICAN engineers extend the hand of welcome to those hundreds of fellow workers who will soon cross the Atlantic and the Pacific to attend the Third World Power Conference.

For the first time in the twelve-year history of the conference, America is host. Her guests will include many who greeted American visitors twelve years ago in London, six years ago in Berlin and at other times in sectional meeting at Basle, London, Barcelona, Tokio and Stockholm.

In all, it is reported, nearly 700 engineers will make the long journey. They will find on these shores the warm-hearted cordiality and the stimulating contacts that have always been characteristic of W.P.C. meetings.

A detailed account of the conference appears on page 458. Briefly, the program centers on a week of sessions and social events in Washington, D. C. (Sept. 7-12), preceded and followed by technical tours.

The Washington sessions of the W. P. C. will deal with power and fuel problems in their broad national aspects. They should contribute definitely to conservation of resources and to the development of sound power policies throughout the world.

But this social and economic survey is not enough, as the American Committee realizes. Engineers, as individuals, face their individual technical problems. Hence the tours, designed to exhibit America's best power practices and permit round-table international conferences of engineering specialists in the business-like atmosphere of New York, Chicago, Detroit and similar industrial centers.

These tours, perhaps, will be the most fruitful feature of the Conference, giving visitors an intimate view of America's scientific progress, while "showing them the country."

In America, as in any other country, one must "get around" to have any real understanding of the nation and its people. Like many others, this is a land of strange contradictions, curious inconsistencies. But it is also a land of tremendous achievements, particularly in the fields of engineering, industry and business. These cannot fail to stimulate the imagination of the visitor.

On the personal side, the contacts of 700 foreign engineers with more than a thousand of ours, will certainly create new friendships and a better appreciation of the fundamental bonds that bind together all men of good will everywhere—particularly those dedicated to application of scientific knowledge.

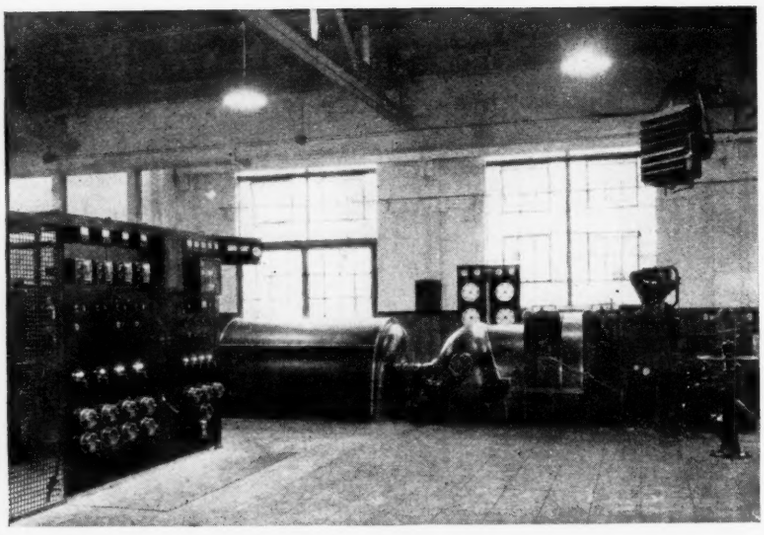
Behind all of the world's amusing variations in accent and superficial custom, the engineer who travels discovers the fact he suspected all along—that men are men and engineers are engineers everywhere.

And so to the official greetings of the American Committee of the World Power Conference we add the unofficial, but equally warm handclasp, of *Power* and of its engineering readership.

Welcome to America!

By
Samuel Blum[1] *and*
Edw. R. Feicht[2]

TOP SAVES $104,000 YEARLY



Double-extraction condensing turbine of 5,000-kw. capacity

High-pressure equipment superimposed on existing plant of Container Corp. of America, meets power requirements without increasing steam demand

FEW, IF ANY, industries lend themselves to the generation of by-product power more readily or completely than a paper mill. This is especially true of mills which do not make the pulp they use.

Container Corp. of America's plant at Manayunk, in Philadelphia, like most paper mills which have developed and grown during many years, reflects in the type of its equipment the progress in paper machinery design and drives, and like most existing plants it must still be provided with a certain amount of steam at pressure required for existing drives.

With the development of high-pressure and high-temperature boilers, the pressure differential above the required existing plant pressure became available and made it possible to superimpose a steam and electrical plant on the existing plant. Steam is thus supplied for all purposes, precisely as was done by the original low-pressure boilers, but this steam, in its drop from the higher boiler pressure through a turbine, produces power at a loss of a relatively small part of its heat content. From the thermal point of view, the cost of a kilowatt with this arrangement is astonishingly low, even when compared with the most modern central station.

The mill produces approximately 500 tons daily of liner board, chip, news, and manilas on five machines, one turbine driven, two engine driven, one engine-generator and one motor-driven.

Steam was formerly produced at 170 lb. by 11 boilers fired by underfeed stokers. The boilers operated at about 63% efficiency, producing steam on an average of 210,000 lb. per hr. With two boilers as spares, units in service were required to operate at over 150% rating. The age of the units, their restricted furnaces, and type of stokers necessitated continued maintenance to carry these ratings.

Originally, the electrical requirements were supplied to the various centers of distribution by means of engine-generators at several points and by the Philadelphia Electric Co. These various centers were not paralleled with each other, nor with the utility service, so that it was almost impossible to maintain an economical balance between current and steam requirements. At times the generator in one section would be underloaded, with steam made up through reducing valves, while the purchased power was high. At other times, the opposite condition would occur.

About 4 yrs. ago, this condition was greatly improved by paralleling two engine-generators with utility service. This change resulted in a material saving in purchased current and about 5% saving in steam per ton of board.

The average current requirements before the recent changes, were about 5,400 kw. per hr., as follows:

Allis-Chalmers Twin Engine	1,500 kw.	1,600 kw.
Hamilton Corliss A.C.	900 kw.	950
Other Generators		350
Purchased Current		2,500
	Total	5,400 kw.

From the foregoing it can be seen that the power- and steam-making equipment had exceeded the limit of safe or economical capacity. Boilers, engines, and transformers were operating at ratings which made continuity of service uncertain. Breakdown was frequent, and maintenance became excessive.

The economic advantage of high-pressure boilers and the possibility of generating all or nearly all of

[1] Engineer, H. M. Wilson Co., Engineers and Constructors.
[2] Supt. of Power and Maintenance, Container Corp.

the current requirements had been recognized for some time, and with indications of improved markets the company proceeded with a program of improvement which could ultimately result in a completely isolated power plant.

In addition to a new 500-lb. boiler, two Badenhausen boilers, installed in 1921 and good for 200-lb. pressure and 70-deg. superheat were modernized with side and rear waterwalls, and their furnaces remodeled for pulverized-fuel firing, thus increasing their capacity to 55,000 lb. of steam each. The new boiler occupies space formerly taken by boilers 1 and 2, and the space formerly occupied by boilers 10 and 11 became available as a pump and filter room. Boilers 6 and 7 will also be removed, and three boilers will be retained and later equipped with oil burners for emergency use. The new unit, in conjunction with either of the Badenhausens, can carry the plant. Space to the right of the stack provides for a future large unit. The new turbine is in a new extension to the old engine room with the outside wall on a line with the existing boiler house.

The new 4-drum bent-tube boiler with side, rear and front waterwalls is designed for a working pressure of 505 lb. and 625 deg. temperature. It is built to produce 175,000 lb. per hr. continually with a 200,000 lb. per hr. peak. It has a heating surface of 12,610 sq. ft.; the waterwalls 4,700 sq. ft. The tubular air heater has a total surface of 16,800 sq. ft.

A special bypass damper and breeching to the stack is available for starting up and permits the boiler to operate up to 70,000 lb. per hr. without operation of either forced or induced-draft fans.

The front wall is arranged V-shape so the center lines of the burners converge at the furnace middle and minimize impinging action on the side walls. To avoid disturbance of water level in the steam drum due to heavy emission from the side-wall upcomer tubes, which are rolled into the steam drum at the ends, a special box is arranged to distribute the water and steam mixture across the entire drum length.

Special doors at the sloped sides of the ash pit make it possible to remove slag and ash accumulations with a water lance, and ash is removed periodically from the pit while the boiler is in service. The boiler has been operated 24 hr. a day for an entire month, at an average output of 180,000 lb. per hr., without shutdown. Over-all efficiencies obtained at various ratings range from 84% at 150,000 lb. to 82.5% at 200,000 lb. per hr.

The new unit is fired by two unit pulverizers, each having a capacity of 12,750 lb. of coal per hr., and two burners. The pulverizers are driven by 100-hp., 850-r.p.m., constant-speed motors.

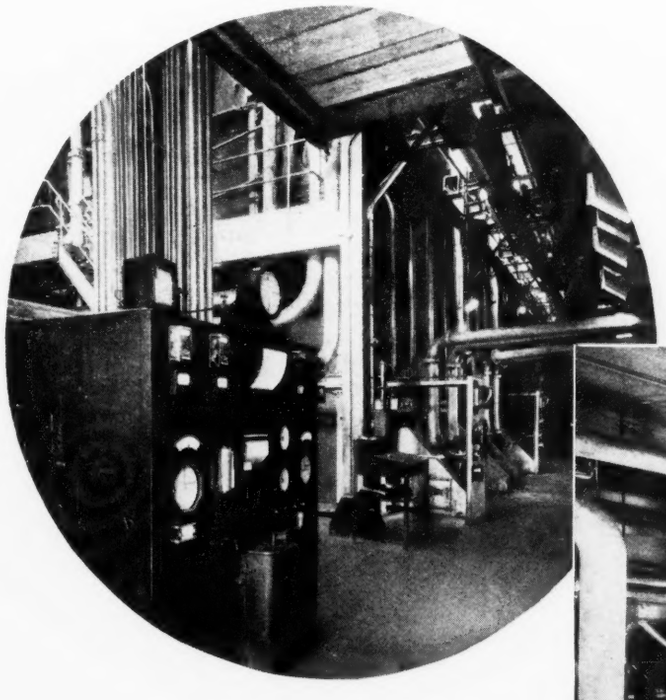
Each of the revamped boilers is fired by one pulverizer having a capacity of 8,000 lb. of coal per hr. and two flare-type burners, with coal-distributing valves at each pulverizer. These units are driven by 60-hp., 1,150-r.p.m., constant-speed motors.

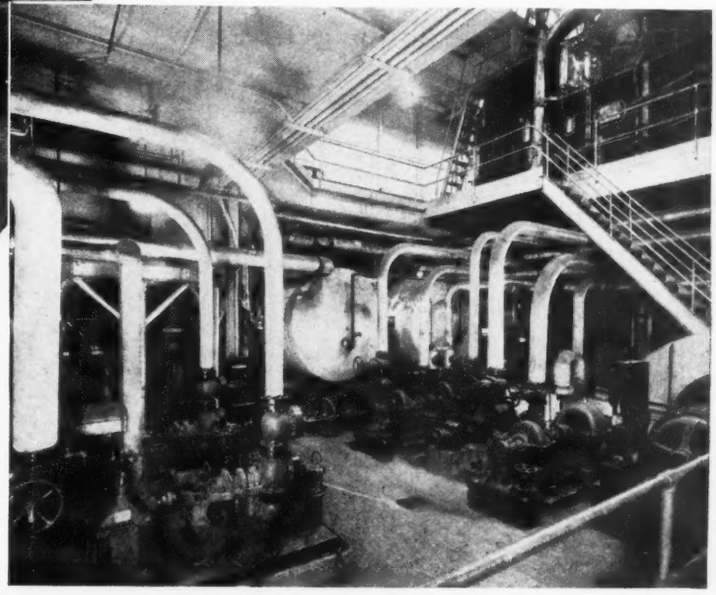
Primary air to all four pulverizers, amounting to approximately 10% of total air requirements, is taken from the outlet end of the main air heater at 375 to 400 deg.

Fineness secured is 80 to 88% through 200 mesh requiring about 14 kw. per ton. A record of maintenance after grinding 59,000 tons shows the cost per ton for parts to be 1.64c and labor 0.55c.

For lighting up, high-pressure mechanical oil burners are provided. The burners are inserted through the center of the powdered-coal burners and are piped up permanently. They are of ample capacity and can be operated in conjunction with powdered coal, or separately to maintain a considerable portion of the rating, if desired.

Water is taken from an adjacent canal and delivered through a blowdown heat-reclaimer to a hot process lime-and-soda softener, with a connection from the city main automatically available for emergency. Makeup, amounting to about 40% of the total feed, is passed through a vent condenser and deaerating heater to the softener. Condensate





Above—Both new and old boilers are fired with pulverized coal. Right—Pump room is behind large control board in foreground of picture above

contaminated with oil is returned through a separate vent condenser and heater. After settling, all water is passed through magnetite filters designed to remove oil as well as other impurities before passing, without silica contamination, to the boiler-feed pumps. Water leaving the filters, a mixture of treated raw water and condensate, still contains about half a grain of hardness, requiring an after-treatment of phosphate, of which an excess of 3 to 5 grains is maintained in the boiler at all times.

About 3 to 4% is blown down continually through a Cochrane flash system, whereby about 27% of the heat is recovered as steam to the 3-lb. exhaust system, and the balance passed through a heat reclaimer to waste at a temperature of about 12 deg. above the incoming water.

Samples of water are analyzed every two hours, and chemical feed and blowdown adjusted to suit. Best results have been obtained with alkalinity at about 18, concentration about 2,000 p.p.m., and excess phosphate at about 3 g.p.g. Boilers were Apexiorized when first installed, and each inspection since has found the drums and tubes free from scale or accumulations. Records show the cost for treatment per 1,000,000 lb. of water to be $0.84 for lime and soda, $1.51 for phosphate.

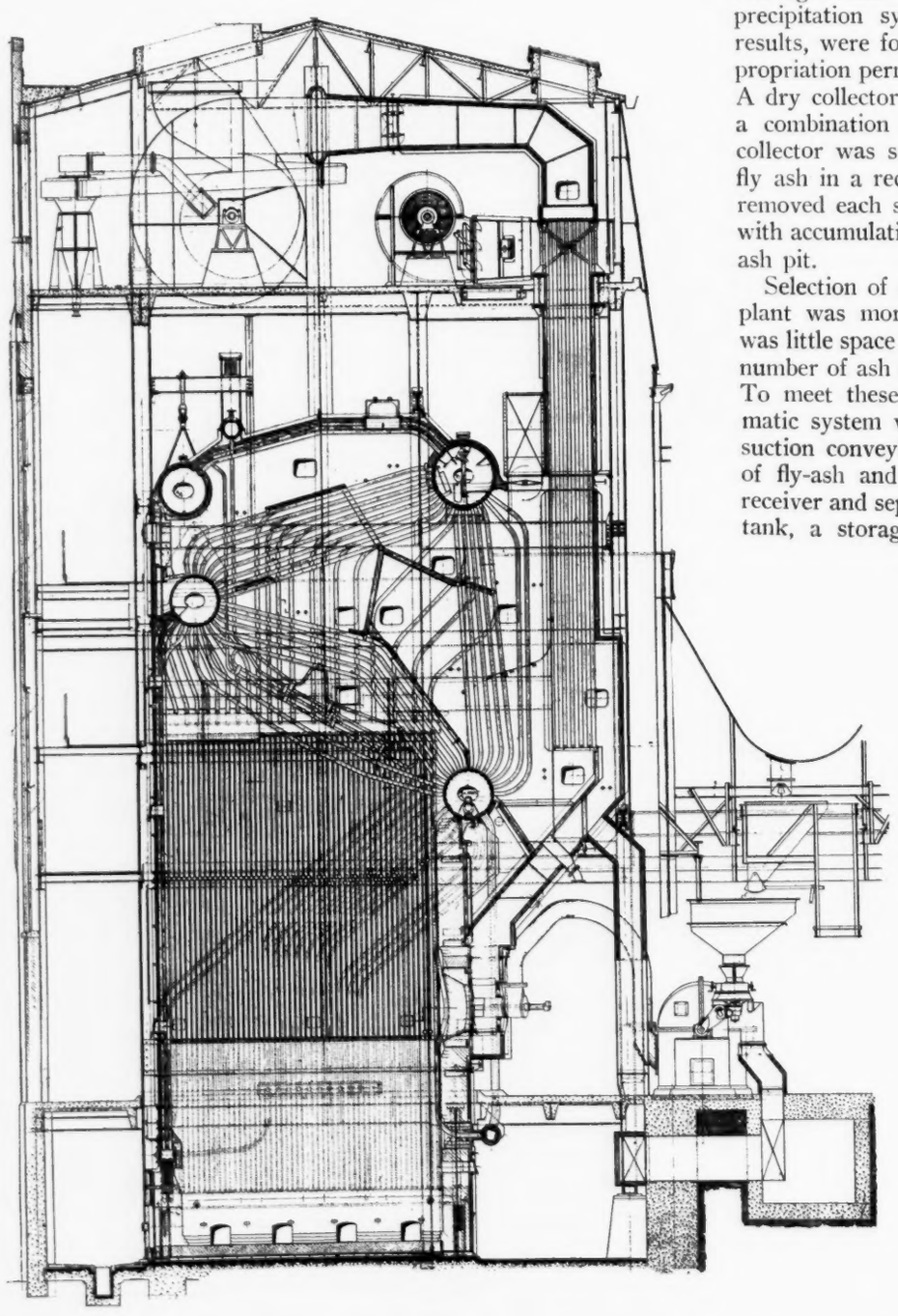
Two centrifugal feed pumps, one motor driven and one turbine driven, operating at 3,500 r.p.m. against 1,380-ft. head, deliver water at 212 deg. and higher to the new boiler. The existing pumps for the low-pressure boilers were relocated so that all pumps are now adjacent to the heater and filters.

Proximity of the plant to a residential section and the desire to avoid product contamination, necessitated study of the fly-ash problem. Systems requiring water were considered, but it was found that to avoid carryover of the fine dust into the Schuylkill River, with consequent complaints from the Game Conservation Authorities, unduly large and costly settling basins would be required. Electrical precipitation systems, though promising best results, were found to be costlier than the appropriation permitted or results would warrant. A dry collector method was decided upon and a combination induced-draft fan and fly-ash collector was selected. The collector deposits fly ash in a receiving hopper from which it is removed each shift by a vacuum system along with accumulations from the boiler hoppers and ash pit.

Selection of a suitable ash conveyor for this plant was more difficult than usual as there was little space available, and there were a large number of ash and fly-ash accumulating points. To meet these requirements a vacuum pneumatic system was installed. It consists of: a suction conveying pipe extending to 18-points of fly-ash and ash accumulation, an air-tight receiver and separator on the roof of the storage tank, a storage tank having over a carload capacity, an unloading device which eliminates all dust when discharging the materials from the ash storage tank into railroad cars.

A high-pressure steam exhauster is used for creating the necessary air flow in the conveyor pipeline. The system which has a 12-ton per-hr. capacity, has been in operation for approximately 1½ yr. and in that time the cost of repair parts has been negligible.

Existing coal-handling equipment was retained, the pulverizers being placed so they could be served by a new traveling weigh larry from the 500-ton bunker.



New 500-lb. boiler with 16,930 sq. ft. of heating surface has peak capacity of 200,000 lb. per hr.

The new 5,000-kw., 3,600-r.p.m. condensing turbine is arranged for automatic extraction of steam at two points. It is operating with steam at 490 lb. gage and 150 deg. superheat at the throttle, and exhausts at 1 in. Hg. abs. Steam is extracted at 170 lb. gage at the high-pressure point, and at 44 lb. gage at the low-pressure point, under the control of internal extraction valves. The generator operates in parallel with existing engine-driven generators and at times in parallel with central-station power.

A 170-lb. main may be supplied with extraction steam from the turbine, with steam from the two low-pressure boilers or from reducing valve from the 490-lb. steam main. Steam is used in the engine-generator sets, engines and turbine for driving paper machines and other auxiliary equipment. The 40-lb. extraction point supplies steam for paper machine drier rolls and for heating beater water.

Demand for 40-lb. steam is the more variable of the two extraction demands, hence would have the greatest disturbing effect on output of the unit. The 40-lb. extraction-valve mechanism and the high-pressure inlet valve gears are, therefore, interconnected through a 3-arm lever mechanism which operates both sets of valves to hold the output of the machine substantially constant with changes in the 40-lb. extraction flow, so long as the 40-lb. extraction valve is away from its stop in the closing direction.

Since 40-lb. extraction steam expands through the greatest pressure range, most economical operation

Table I—Comparative Operating Data

	1933 Based on first 6 mo. per records	1933 Interpolated to correspond to 1935 production	1935 Based on last 6 mo. per records
STEAM PRODUCED			
Total all boilers	1,162,966,400	1,450,000,000	1,384,413,700
Total-equiv. at 170 lb.	1,162,966,400	1,450,000,000	1,452,378,600
Tons of coal	64,670.6	80,500	65,182.5
Kw. GENERATED			
Kw. total generated	15,920,000		39,169,524
Kw. purchased	10,050,000		1,363,400
Kw. total	25,970,000	32,300,000	40,532,924
PER TON OF PAPER			
Steam as generated	10,850	10,850	10,400
Equivalent 170-lb. steam	10,850	10,850	10,900
Lbs. of coal	1,205	1,205	977
Kw.-hr.	244	244	305

is secured by giving preference to the 40-lb. line at the expense of the 170-lb. demand, and making up the 170-lb. demand from the low-pressure boilers. To take advantage of this saving, the 170- and 40-lb. extraction valves are interconnected through a preference mechanism which causes the turbine to satisfy the 40-lb. extraction steam demand first, then to satisfy the 170-lb extraction. Only when there is a paper break, with resultant drop in 40-lb. steam requirements but no material reduction in current requirements, is the condenser called upon to absorb much more than minimum steam flow.

The entire water requirements of the plant are pumped through the condenser, from the adjoining canal. Former pumps were found to be adequate even after introducing the condenser and strainers to the system. The amount of heat recovered, although slight, is an aid in process and is not lost.

The existing electrical system of distribution was 460 volts, 3-phase, 60 cycles. In 1929, when the generators were paralleled with the utility company, all tie-lines were installed for 460 volts to match this existing equipment. Distribution centers were not too remote from the generator, and it was for this reason that the new 6,250-kva. generator was wound for 460 volts, rather than the higher voltage which would have necessitated a transforming loss.

Records for operation over six months, a total of 3,617 hr., showed the following average hourly quantities: kw-hr. produced 5,220; steam to throttle 128,800 lb.; to 170-lb. extraction 24,900 lb.; to 40-lb. extraction 92,500 lb.; and to condenser 11,400 lb. This checks closely and is slightly better than the guarantee performance.

In judging the performance of the new equipment, comparison of operation is made by selecting data for the first six months of 1933 and the last six months of 1935. The period in between could not be considered representative since operation was erratic, expensive major repairs being made to the old boilers and cost charged to maintenance. In 1933, production was lower, and to secure comparable conditions, the figures in Table I are interpolated to correspond to 1935.

From the comparison it can be seen that for like production, total steam remains unchanged, but total coal consumption has dropped from 80,500 tons to 65,182 tons, and per ton of product from 1,205 lb. to 977 lb.

Total power requirements have increased because of boiler-room auxiliaries and some additional electrification in the plant, but the purchased current has been reduced to less than 10% of the former amount. A comparison of operating costs, including interest and depreciation on capital investment of over $500,000 shows a saving of $104,000 per year, or a reduction in the cost for power and steam of 76 cents per ton of product.

PRINCIPAL NEW EQUIPMENT
Container Corp. of Amer. Phila., Pa.

Boiler, 200,000-lb. per hr., 536-lb. pressure, 625-deg. 12,610 sq. ft., waterwalls 4,700 sq. ft., air heater 16,800 sq. ft., 2 pulverizers, flare-type burners, 12,750 lb. coal per hr. — Riley Stoker Corp.
Mechanical oil burners for lighting up — Schutte & Koerting Co.
Forced-draft fan, 75,000 c.f.m. — B. F. Sturtevant Co.
Induced-draft fan, 125,000 c.f.m. — American Blower Corp.
Boiler feed pumps, 450 g.p.m., 1,380-ft. head — Ingersoll Rand Co.
Heater, settling tank, filters, continuous blowdown — Cochrane Corp.
Soot blowers — Vulcan Soot Blower Co.
Combustion Control — Brooke Engineering Co.
Desuperheaters — Elliott Co.
Water columns — Reliance Gauge Column Co.
Turbo-generator, 5,000 kw., 3,600 r.p.m. — General Electric Co.
Condenser, 2-pass, 2,400 sq. ft. steam jet air pumps, condensate pumps, switchboard — Westinghouse Elec. & Mfg. Co.
Bus work — Ross Electric Co.
Atmospheric relief — Atwood & Morrill
Pressure-reducing valves — H. Belfield Co.
Non-return valves, triple-duty — Golden Anderson Valve Specialty Co.
Blowoff valves — Cochrane Corp.
Traps — Strong Carlisle & Hammond Co.
Non-return valves, oil operated — Atwood and Morrill
Valves — Lunkenheimer / Jenkins Bros.
Feedwater regulators — Swartwout Co.
Piping (fabricated by Benj. F. Shaw) — Frank Nelson & Son
Pipe insulation — John R. Livezey Co.
Weigh larry — Webster & Weller Mfg. Co.
Ash and soot handling — United Conveyor Corp.
Soot collectors — American Blower Corp.
Flowmeters and CO_2 records — Republic Flow Meters Co.
Pressure and temperature recorders and 6-point potentiometer — Brown Instrument Co.
Pressure gages — Consolidated-Ashcroft-Hancock Co.
Draft gages — Bailey Meter Co.
Gage boards — Pringle Electric Co.

USE LARGER PIPES TO REDUCE

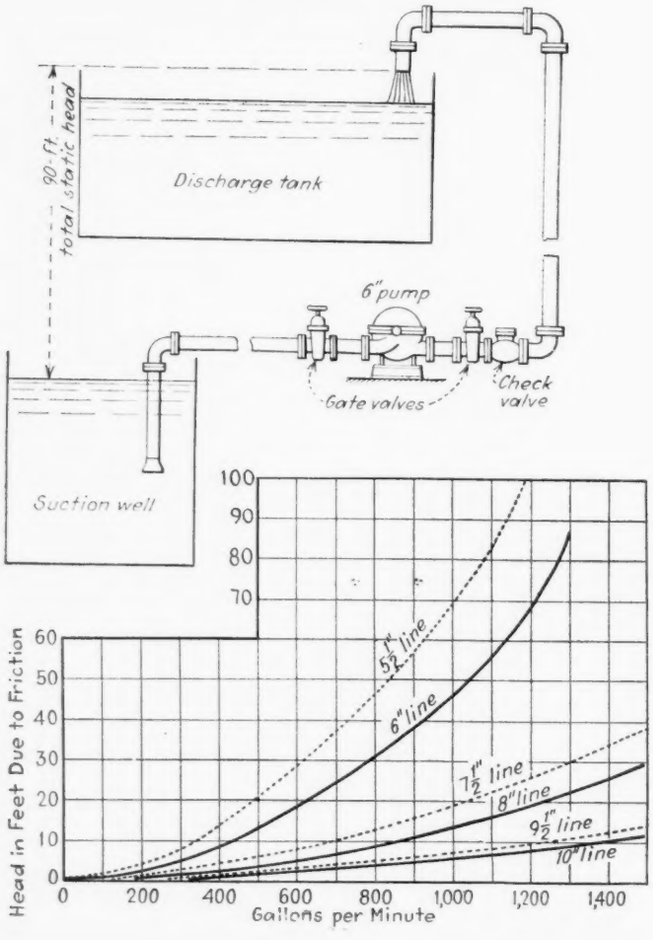
How to select the size of pipe that will give lowest pumping costs

By Frank A. Kristal
Mechanical Engineer, New York, N. Y.

A PUMP is but one part of a pumping system. From that standpoint an entire new layout should be analyzed as a unit to insure the most economical combination of equipment. Since such an analysis is not difficult, it is surprising that the method here described has not been used more generally when planning new pumping installations.

For simplicity, assume a typical layout, Fig. 1. In this case, the purchaser desires to transfer 360,000 gal. of water per day from the suction well to the discharge tank. He figures on pumping about 6 hr. per day, and operating about 300 days per year, at a rate of 1,000 g.p.m. From the pump manufacturers' catalogs, the purchaser finds that he will need a 6-in. pump. Location of the suction well and discharge tank indicates a 90-ft. total static head.

Fig. 1 (Below) — Diagrammatic layout of a pumping system. Fig. 2 (Bottom) — Pipe-line characteristic curves



These two items, size of pump and static head, are definitely determined, regardless of the size or arrangement of the piping used. The variable factor is friction head, and it is in a study of how the piping affects this element that a considerable saving in the cost of pumping may be made.

Let us suppose that the piping system requires 200 ft. of straight pipe, six elbows, two gate valves, and one check valve. Loss of head due to friction in this equipment depends on the size of pipe used, as shown in "How Big a Pipe for Your Pump?", *Power,* May, 1936, pages 264 to 266 and 272. For the water to be handled by this system, there is a choice between 6-in., 8-in. and 10-in. piping.

Table I indicates the method of working out the total dynamic head for the sizes of pipe. This tabulation is based on the "Data Sheet," page 272, May *Power*. There are 200 ft. of straight pipe in all three sizes, and this item heads each column. From the table of fittings, May *Power,* a 6-in. standard elbow causes a friction loss equivalent to 18 ft. of straight pipe, a gate valve to 7 ft., and a check valve may be taken as equivalent to a globe valve, or 52 ft. of straight pipe. Then, six elbows will cause a friction loss equivalent to $18 \times 6 = 108$ ft., two gate valves $7 \times 2 = 14$ ft. and a check valve 52 ft. of straight pipe. These are the values in the first column of the table. Values for the 8-in. and 10-in. pipes are found in a similar way and are given in the second and third columns of the table. The total equivalent length of straight pipe will be the sum of the four items, in each case, as in the fifth line of the table.

In the Data-Sheet tables, a flow of 1,000 g.p.m. in a 6-in. pipe causes a friction-head loss of 12.04 ft.; in an 8-in. pipe 3.02 ft., and in a 10-in. pipe 1.01 ft., as shown in Table I. Total friction head for the 6-in. pipe equals $(374 \div 100) \times 12.04 = 45$ ft. In a similar way, total friction head for the 8-in. pipe is 13.26 ft. and for the 10-in. pipe 5.23 ft., as shown in Table I. These values added to the static head give a total dynamic head of 135 ft. for the 6-in. pipe, 104 ft. for the 8-in. pipe and 96 ft. for the 10-in. pipe.

Pump Characteristics

Thus, with 6-in. piping, we would require a 6-in. pump, designed for 1,000 g.p.m. against a total head of 135-ft. Fig. 4, characteristic curves *A*, indicate the performance of the centrifugal pump suitable for this service. At the rated conditions the pump has an efficiency of 74% requiring 46 hp. Assuming a 90% motor efficiency, the power input will be approximately 38 kw. On the basis of 6-hr. operation per day, this means a power consumption of 228 kw.-hr. Estimating the cost of power at 2c. per kw.-hr., the cost per day would be $4.56 or $1.368 per year. A 50-hp. motor would be necessary. The cost of the 6-in. high-head pump with a 50-hp. squirrel-cage induction motor and suitable starter would amount to approximately $900.

Using 8-in. pipe, we need a pump for 1,000 g.p.m. against 104-ft. total head. In Fig. 4, characteristic

PUMPING COSTS

curves *B* are for this pump. At rated conditions, the pump has an efficiency of 82 per cent and requires 32 b.hp. At 90% motor efficiency, power input will be about 26.5 kw. This amounts to 159 kw.-hr. per day, at a cost of $3.18, or $954 per year. In other words, there is a saving of 1368—954=$414 per year in power cost by using 8-in. pipe instead of 6-in. The pump will require a 40-hp. motor only, the cost of which (pump motor and starter) will be approximately $740, or 900—740=$160 less than when 6-in. pipe was used.

For 10-in. piping and fittings, we need a pump for 1,000 g.p.m. against 96-ft. total dynamic head. Fig. 4, characteristic curves *C*, are for a pump suitable for this service. At the rated conditions the pump has an efficiency of 82%, requiring 29.6 b.hp., or 24.5 kw. at 90% motor efficiency. Such a unit will require 147 kw.-hr. per day, at a cost of $2.94, or $882 per year. This is a saving of $72 per year as against the use of 8-in. pipe and $486 per year less than when 6-in. pipe is used. In this case the pump can be installed with a 30-hp. motor, and the cost of the unit with starter is approximately $670.

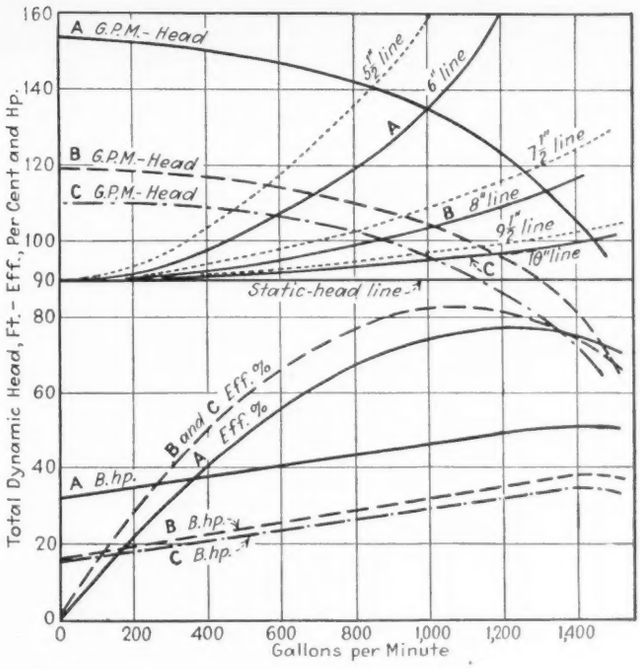
Table II gives the cost of piping, fittings and pumping unit for each of the three sizes of pipe. The pump and 8-in. pipe is the cheapest in first cost. Erection cost would be approximately the same for all three, therefore, they have not been taken into consideration, as they will vary for different localities. Yearly power costs for each unit based on 300-day-per-year operation amounts to $1386 for 6-in. pipe, $954 for 8-in. pipe and $882 for 10-in. pipe. Study of these figures would indicate that 8-in. pipe presents the most attractive proposition from the basis of first cost, and approximates the lowest operating costs.

To view the problem in a more simplified form,

Table 1—Items Comprising Total Dynamic Head on the Pump

Items	Equivalent Feet of Straight Pipe 6-in. Pipe	8-in. Pipe	10-in. Pipe
Straight pipe, ft	200	200	200
Six standard elbows	108	144	192
Two gate valves	14	20	26
One check valve	52	75	100
Total equiv. ft. of straight pipe	374	439	518
Friction head, ft., per 100 ft. of pipe	12.04	3.02	1.01
Total friction head, ft	45	14	6
Static head, ft	90	90	90
Total dynamic head, ft	135	104	96

let us show some of this data graphically so that comparison may appear more evident. For the three sizes of pipe, we make up the pipe-line characteristic curves of Fig. 2, and plot a composite set of curves as in Fig. 3, which shows the characteristic curves for the pump together with the curves for pipe-line friction. The horizontal static head line is the same for all three cases, as static head remains constant regardless of what size piping is used. For complete instructions on how to plot the curves, Figs. 2 and 3, see the article in May Power, previously mentioned.



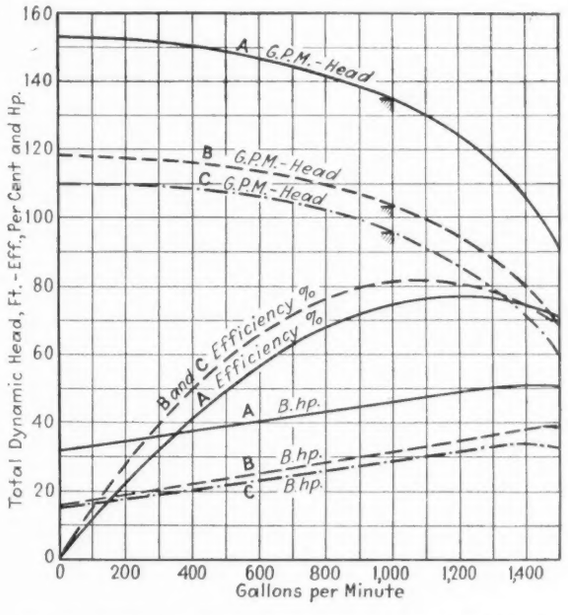


Fig. 3 (Top)—Pipe-line characteristic curves combined with those for a pump. (Fig. 4 (Above)—Characteristic curves for three pumps

From these curves we may try combinations of pumps and piping other than those already consid-

Table II—Cost of Pumping Unit Using 6-, 8-, and 10-In. Pipe

	6-in. Pipe	8-in. Pipe	10-in. Pipe
Cost of pump with motor and starter	$900	$740	$670
Cost of 200-feet of straight pipe	240	300	385
Cost of six (6) elbows	30	48	96
Cost of two (2) gate valves	40	65	108
Cost of one (1) check valve	24	42	70
Total	$1,234	$1,195	$1,329

ered. For example, if 8-in. piping is used with the pump that would be selected for 10-in. piping, then its delivery capacity is only about 900 g.p.m., that is, the *C* g.p.m.-head curve and the 8-in. pipe curve cross at about 900 g.p.m. If this arrangement were used, then it would be necessary to operate the pump for $360{,}000 \div (60 \times 900) = 6.66$ hr. per day to deliver 360,000 gal. With the capacity and head thus reduced, the brake-horsepower required to drive the pump becomes 28.7, which at 90 per cent motor efficiency equals 23.7 kw. or 158 kw.-hr. per day on the basis of the 6.66-hr. operation, and the annual power cost would be $948. A 30-hp. motor would have sufficient capacity, and the cost of the unit, using the 6-in. pump with 30-hp. motor and starter, would be about $1,125. This unit costs $1,195—$1,125=$70 less, and the annual power cost is the same as for the original 6-in. pump and 8-in. piping. Thus, it may be found advisable to figure on running the unit for 40 min. longer each day to reduce installation and operating costs.

Reduction in pipe size due to internal deposits should be taken into consideration when chosing the pipe. These deposits may seriously affect operation of the pumping system, due to reduction in pipe cross-sectional area. Assume that after a period of operation, there is approximately 0.25 in. of rust inside the pipe. This would reduce the 6-in. pipe to 5.5-in., the 8-in. pipe to 7.5-in. and the 10-in. pipe to 9.5-in. diameter. By plotting friction characteristic curves for these odd sizes of pipe, as shown in dotted lines Figs. 2 and 3, we can study the effect of pipe corrosion on the pumping system.

It is evident that the 6-in. piping system is ruled out of consideration when deposits are considered. The reduction in capacity would so increase the cost of operation as to make this an uneconomical system to install. This reduces the problem to a comparison of the 8-in. and 10-in. piping systems. With 8-in. pipe, 0.25-in. of rust reduces the pumping capacity approximately 60 g.p.m., whereas in the 10-in. pipe the reduction in capacity is almost negligible. For the 8-in. pipe the head is increased several feet more for the system than for the 10-in. pipe, which will increase the power consumption and cost, when the longer pumping time is taken into account. Taking everything into consideration, it may be found best to select the 10-in. pipe and 6-in. pump; as being the most economical to install from the standpoint of future economy as well as present low operating costs, even though the first cost of the equipment is $134 higher than for 8-in. pipe. The power cost is, however, $72 per year less using 10-in. pipe than for 8-in. pipe. This, in two years will equal the excess cost for the larger pipe, which makes the 10-in. pipe the most economical of the three propositions. As pipe diameter is reduced, the increase in power for pumping will be much less for the larger pipe than the smaller, another factor in favor of 10-in. pipe.

A factor frequently overlooked when selecting pipe for a pump is that the use of water and, consequently, the pumping time, are far more likely to increase than decrease. Any increase in pumping time favors the larger pipe. For example, if the pumping time doubled, the power saving would pay the extra cost of 10-in. pipe over 8-in. pipe in one year.

ARE SAFETY VALVES ACTUALLY SAFE?

By Philip W. Swain
Editor of POWER

RECENT official tests of safety valves reveal a condition which is causing considerable concern in steam engineering circles. Tests prove that valves rated by the A.S.M.E. Boiler Code formulas may actually fall short of their rated relieving capacity by as much as 84% in extreme cases, giving completely inadequate protection to the boiler, the plant and the personnel.

The tests referred to were made by the steam engineering laboratory of the Ohio State University for C. O. Myers, secretary-treasurer of the National Board of Boiler & Pressure Vessel Inspectors. Each of the safety valves tested was stamped by the manufacturer with the relieving capacity computed from the A.S.M.E. formula as found in the boiler code.

It soon became apparent that computed capacities are one thing and actualities are another, for valves tested in the first series fell short of their stamped ratings anywhere from 20.3 to 84.3%.

Taking the tests of the first series in order, without identification of the valves, the percentages of rated capacities were as follows: 56.8, 53.2, 52.8, 73.2, 73.3, 75.9, 37.0, 15.7, 45.2, 70.8, 59.0, 79.7, 60.0, 38.3.

The picture is brightened somewhat by results obtained with another group of valves tested several months later. These delivered, respectively, the following percentages of their rated capacities: 97, 98.8, 100.8, 115. These valves, we are informed, had been rated by test rather than by formula.

Neglecting, for the moment, those valves that did practically equal or exceed their rating, it is evident the tests, as a whole, reveal a serious situation, particularly in view of the fact that they were carefully made by disinterested parties.

The moral apparently is that purchasers of new safety valves should insist upon rated capacities being established by actual tests, rather than by formula, and that the users of existing safety valves should have an accumulative test run on their boilers in the presence of a qualified boiler inspector to determine if the safety valves will actually relieve all of the steam the boilers can generate.

Where the plant contains many safety valves, all of the same make and size, and all set for the same pressure, it should not be necessary to test each valve individually; presumably they will perform alike within reasonable limits.

Since these tests were made, the A.S.M.E. Boiler Code Committee has deleted from the Code the formula for rating safety valves by dimensions of the valve opening.

CHLORAMINES CLEAN CONDENSERS

By M. S. Maurer
Chief Chemist,
Brooklyn-Manhattan Transit System

FOR SOME time it has been known that slime on condenser tubes is of bacterial origin and reduces heat transfer. At many plants the circulating water is treated, for comparatively short intervals, with chlorine gas or hypochlorite which kills the organisms, thus facilitating their subsequent removal by the circulating water.

The amount of chlorine or chlorine compound used depends on the nature and amount of pollution from sewage and industrial waste in the water. Chlorine, very active chemically readily combines with many of these foreign substances. Materials in the water that combine with chlorine and thus destroy its usefulness as an antiseptic are collectively known as the chlorine demand of the water. It is necessary to use sufficient chlorine to take care of this demand and provide an excess available for use as an antiseptic. In polluted waters the chlorine to satisfy the demand becomes excessive and treatment is uncertain.

A material that is not so readily affected by substances in the water and of sufficient antiseptic value would have definite advantages. Chloramines appear to have this desirable property. They also have in the presence of pollution, a greater antiseptic value than chlorine.

Chloramines are formed by combining the ammonium radical with chlorine, there being three of them, mono-, di-, and tri-chloramine. The one predominating when they are formed depends on the hydrogen ion concentration of the water, which, under most conditions, favors formation of mono- and di-chloramines.

Method of formation will depend on circumstances but in general for power station use we believed it desirable to get away from gaseous material. When solid materials such as ammonium sulphate and bleaching powder or other chlorine compounds are used, the apparatus for handling them becomes inexpensive and simple.

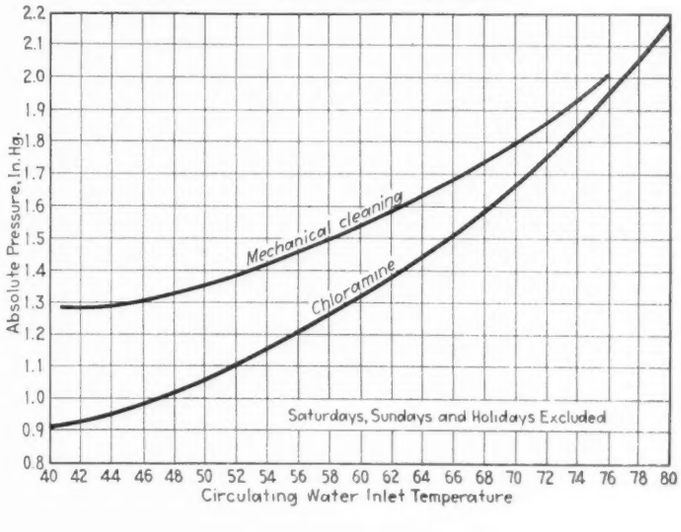
At Williamsburgh Power Station we became interested in germicidal treatment of condensers some years ago. A trial installation using chlorine was made, but due to the comparatively high chlorine demand of the water, which varied from 2 to 20 p.p.m., no worthwhile results were obtained and it appeared hopeless that we would be able to use this method of slime control. It was decided to try out chloramines and accordingly experimentation was begun with bleaching powder and ammonium sulphate. Treatment was made with the condenser in operation and only three variables had to be considered: duration, concentration and frequency of application. After numerous trials, it appeared in our case, that a dosage for ½ hr. at a concentration of 4 p.p.m. once in 24 hr. was satisfactory.

Solutions of the two chemicals are introduced simultaneously at the circulating pump suction through separate orifices, the ammonium sulphate entering about 1 ft. upstream from the bleaching powder. It is necessary in the case of bleaching powder to arrange for continuous agitation and a method of clearing the outlet pipe in case of clogging. This is done by stirring with air and putting air pressure on the tank. The ammonium sulphate is dissolved in an open container. Both tanks have gage glasses so that the solutions can be introduced at the same rate. Ratio of bleaching powder to ammonium sulphate is 5 to 1. This appears to be the optimum ratio for the formation of chloramines. To economize on chemicals the circulating pumps are slowed to half speed during dosage.

Results obtained have been very satisfactory. Accompanying curves giving the operating performance of a 50,000 sq. ft. Wheeler condenser with and without chloramine treatment show what has been accomplished. Circulating water conditions are particularly bad, and previous to use of chloramine, it had been necessary to mechanically clean the condensers, ordinarily by scrapers, about once a week. There have been periods when it was unnecessary to do any mechanical cleaning for over a month while chemicals were being used. It should be said, however, that slime is not the sole reason for mechanical cleaning. Due to the rapid deterioration of the tubes, the interior surfaces become rough and heavily coated with corrosion products. Silt and mud collects in the tubes, making it necessary to scrape the tubes, particularly in warm weather, at frequent intervals. This mechanical cleaning has been materially reduced by the use of chloramine.

There has been no evidence that chloramines are detrimental to the tubes and no basis to believe they would be.

Comparison of condenser operation when cleaned mechanically and when using chloramines



RAMBLES

By Philip W. Swain
Editor of POWER

Fig. 1—Zurich, with the Lake in its front yard and the Alps just beyond

DR. ADOLPHE MEYER, managing director of Brown, Boveri & Co., Baden (Switzerland), had offered to show me first-class mountains and machines if I could get to his land-of-the-sky by Thursday, March 19. As explained in July *Power*, I kept this appointment by some fast hoofing through Dresden, Prague, Vitkovice, Vienna, Nuremburg and Munich.

Landing in Zurich on the appointed afternoon, I was met at the station by Dr. and Mrs. Meyer, whose acquaintance I had previously made in New York and in Cincinnati. Further American touches were supplied by a 7-passenger Buick (imported to negotiate Swiss mountain roads) and the honorary "Doctor of Engineering" awarded by Stevens Institute in 1935.

After getting us settled in our hotel, Dr. Meyer drove us through Zurich. Then we circled Lake Zurich, and had tea in a mountain chalet, landing finally again at Dr. Meyer's home ("Zur Haab" in Kusnacht) on the shore of the lake. This charming spot will be long remembered for its private boat house and sail boat, its big police dog, its bronze statue of little Peter Meyer on the fountain in the garden, and its general air of friendly hospitality.

Zurich, a city of 250,000, largest in Switzerland, is a place of wonderful beauty, with the lake in the front yard and the Alps in full view. Fine people in a fine setting. That describes all Switzerland.

Here is a little country, smaller than New York State, endowed by nature with little more than scenery, hydro power, and the makings of fruits, cheese, vegetables and wine. No coal, no iron, no oil! The 5,000,000 Swiss meet the situation by using their wits. They export machinery without the natural resources (except water power) of which machinery is made—unless one rates a high-class human stock as a natural resource.

My engineering tour, with Dr. Meyer as a guide, started Friday morning with a visit to Switzerland's national engineering school, *"Eidgenossische Technische Hochschule,"* in Zurich. Then we drove 22 kilometers (about 15 miles) to the town of Baden, home of ancient landmarks and ultra-modern machines. Here are some of the mechanical developments I saw in the Brown-Boveri factory: Velox boilers, gas turbines, high-efficiency turbo compressors, diesel superchargers running at 30,000 r.p.m., "pancake-welded" turbine disks, water-jet electric boilers, "Frigibloc" hermetically sealed refrigerating plants.

The Velox boiler, while several years old, is the most astonishing of these developments. I saw many units in various stages of construction. More than 34 units are now in operation or on order. Here are the principal facts and claims: 1. Cold to full load in 5 min. 2. No load (hot) to full load in 20 sec. 3. Maximum gas velocity: over 650 ft. per sec. 4. Maximum evaporation: over 100 lb. of water per sq. ft. per hr. 5. Maximum heat release: 900,000 B.t.u. per cu. ft. of furnace volume per hour. 6. Furnace volume: about 1/10 that of a normal boiler. 7. Furnace pressure: about 20 lb. per sq. in., gage. 8. No refractories. 9. Forced circulation of from 10 to 20 times the weight of water evaporated. 10. Mechanical separation of water and steam. 11. Incorporates a gas turbine driving a turbo-compressor for combustion air. 12. Completely automatic governing. 13. Over-all efficiency of 90 to 93%.

Two 165,000-lb.-per-hr. units (pictured on page 333 of June *Power*) for the central station in Oslo, Norway, were being erected on the main floor. Pressure is 390 lb. and temperature 800 deg. F. Firing will be by fuel oil (all Velox boilers to date are oil or gas-fired).

Very briefly, the Velox boiler operates as follows: A turbo compressor driven by a gas turbine (or motor, in starting), maintains a combustion pressure of 20 lb. gage in the oil (or gas) fired combustion chamber. After transferring much heat by radiation to the vertical tubes of the waterwall, the gas passes at high velocity up through annular spaces in the multiple-walled tubes. In the upper half of these tubes the gas also passes over the inserted superheater elements.

Then, at 18 lb., and cooled to the safe temperature of 900 deg. F., the gas passes to the gas turbine, exhausting at 1 lb. gage and 750 deg., to the economizer. It enters the stack at about 200 deg. F.

Feedwater from the feed pump passes through the economizer to the steam separator. Main circulation (10 to 20 times the amount evaporated) is by a special circulating pump. After driving up through the evaporator tubes at high velocity, the mixture of water and steam goes to the separator (no moving

OF AN ENGINEER

III—Mountain Air and New Ideas

parts) where the steam is separated by centrifugal action.

This unique steam generator is the practical outgrowth of a suggestion made by Dr. Meyer after Brown-Boveri had worked for years developing high-efficiency turbo-blowers and gas turbines (including diesel-engine superchargers). Its development involved also much hard work by W. G. Noack, chief engineer of the B.B.C. steam-turbine factory.

Velox Boiler

The typical Velox boiler of today (but not the Oslo unit) involves an interesting practice—spiral welding of the evaporator shell. Everybody knows that a girth seam carries only one-half the stress of a longitudinal seam. A 45-deg. spiral hits about half-way between, so Brown-Boveri and certain other European manufacturers eliminate the longitudinal seam entirely and use a spiral seam instead—wrap up the shell plate like a spiral puttee.

A recent B.B.C. development is the welding together of holeless turbine disks (Fig. 4). This design eliminates all holes in disks and insures the proper shaping and forging of each disk. After welding the assembly is stress-relieved and machined.

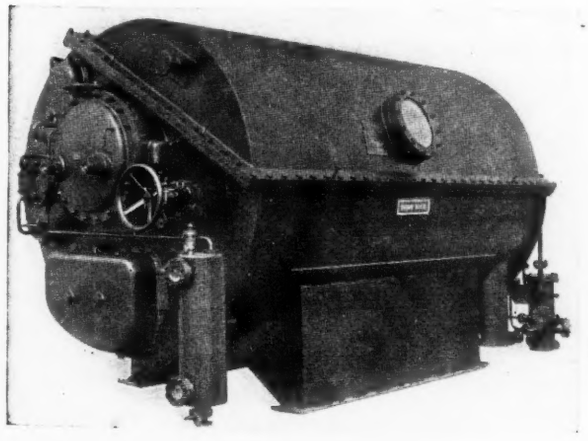
The water-jet electric boiler, previously mentioned, places the three (3-phase) electrodes around a central water column containing three vertical rows of orifices. As the water level in the column is raised, more and more jets spout out to touch the electrodes. These jets complete the electrical circuit, and their number (as controlled by water level in the column) controls the resistance and output of the boiler.

My space, as usual, is running short and I can only mention briefly the B.B.C. diesel superchargers made under the Buechi license. These small outfits, running at from 6,000 to 30,000 r.p.m., have now been adopted by many diesel builders. They are nothing but gas turbines, driven by the engine exhaust, and, in turn, driving turbo air compressors.

On Saturday morning I had an interesting visit at the Escher-Wyss plant in Zurich. There I met H. Guyer, general manager of the plant, H. Bloomer, chief of the patent department, and F. Flatt, chief engineer of the steam-turbine department. You've probably heard the joke about the "Swiss Navy." Fact is, it isn't a joke at all, as I learned at Escher Wyss. The Swiss Navy is all over the globe—in little pieces. Switzerland has made some of the most outstanding recent contributions to naval engineering, notably the Brown Boveri Velox boiler, the Escher Wyss centrifugal steam pump for the Loeffler boiler, and the Sulzer monotube boiler.

Unusual Turbo-compressor

At Escher Wyss I saw many interesting turbines and turbo-compressor units. For example, an 800-hp., 8,000-r.p.m. turbine-driven turbo compressor with the condenser shell cast integral with the lower half of the turbine casing. This particular unit, with seven radial-flow compressing stages, was built of corrosion-resisting metal to handle acid gases.



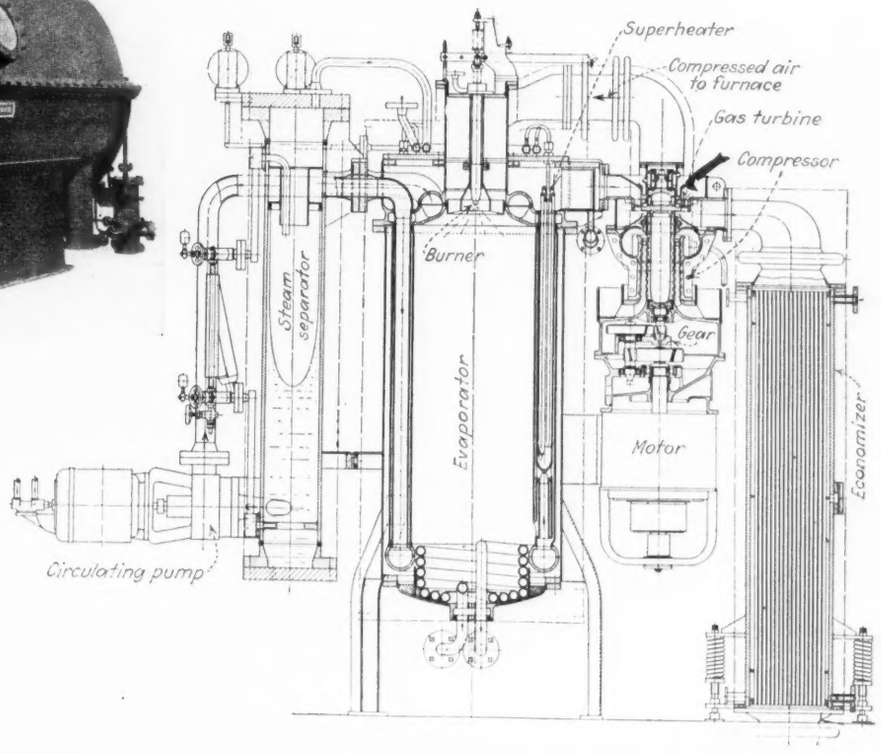


Fig. 2 (Above)—"Frigibloc" is a complete refrigerating plant sealed gas-tight in a steel tank. Fig. 3 (Right)—This small Velox boiler, built for 11,000 lb. steam per hr. at 1200 lb. pressure and 880 deg. F., supports most of the auxiliaries from the evaporator shell

In the shipping room was one of two 1,250-hp., 1,900-lb. pressure, 9,200-r.p.m. steam turbines for *S.S. Conti Rosso.* A lot of fine machines were going through the Escher Wyss shops. I particularly regret that there was not time to study the many hydraulic turbines on the floor.

Over the week-end, Dr. Meyer and family drove me through Lucerne to Engelberg, hopping-off place for Alpine climbers. After spending Saturday night at Hotel Bellevue, full of skiers, we took the cog railway and cable basket up to the 6,000-ft. level on a mountain whose peak towered another 4,000 or 5,000 ft. above us. The snow at this level was dotted with skiers, men and women—at least 200 of them, and not a tyro in the bunch. Brilliant sun, air like crystal. No wonder the Swiss are proud of their up-and-down country. Dr. Meyer, by the way, is an old hand at skiing and Alpine climbing. He told me of many exciting experiences.

Monday morning I took the train from Zurich to Winterthur (about 20 miles) to visit Sulzer Bros. This visit proved altogether too short. I had to start back to Zurich in time to catch the early afternoon train for Paris and I saw just enough to make me realize what I was missing. It was a pleasure, though, to chat with Managing Director Robert Sulzer, Director J. Gaspar, Max E. Treschel, chief engineer of the diesel department, and Mr. Juzi, engineer on Sulzer monotube boilers.

Fig. 4—Forged disks are welded together at the edges to form this Brown Boveri turbine rotor

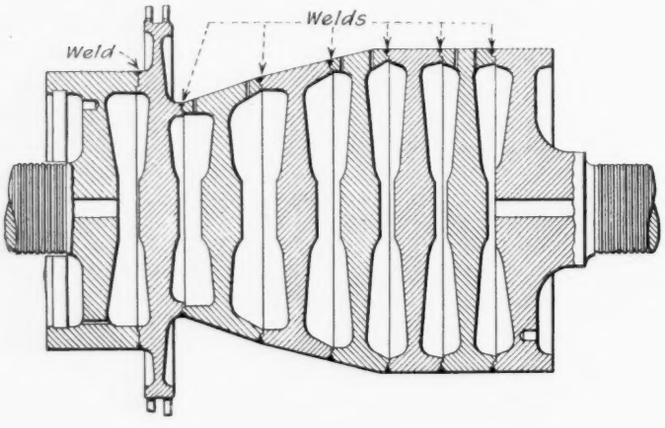
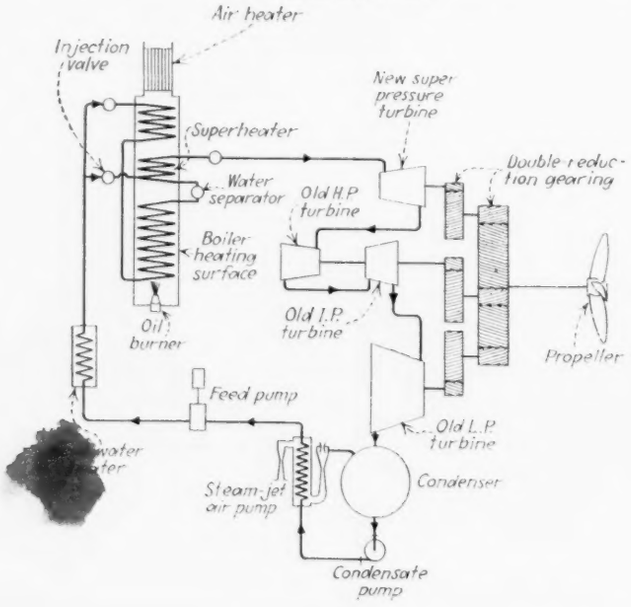


Fig. 5—Power hookup diagram of S.S. "Kertosono" of the Rotterdam Lloyd after application of new high-pressure Sulzer-Monotube "top"



Sulzer is an ancient and honorable name in engineering circles; the beginnings of the firm can be traced back to 1775. Today, in normal times, 6,500 men are at work in the factories at Winterthur and Ober Winterthur. The visitor is struck with the size of erecting floors and machine tools and with the great amount of large work under construction. The main diesel erecting floor, in particular, was full of large engines going through, and I greatly regret not being able to pass along some information on these very impressive units.

Here, as at Brown Boveri, I found spiral welding widely used for boiler drums and pressure vessels and was informed that it has been practised by Sulzer for many years. The plant was elaborately equipped for rolling large plates, testing welds, etc.

I have already discussed at some length certain radical European boilers, notably the Benson (Germany), the Loeffler (Czechoslovakia) and the Velox (Switzerland). To complete the list of those of major interest, one must add the La Mont and the Sulzer monotube. Except at the Leipzig Fair, I was unable to find opportunity to study the La Mont, but would not wish that fact to stand as my estimate of its importance. It is, in fact, widely used in Europe.

But I must get back to the Sulzer monotube. As the name implies, the heating surface is in the form of a single very long tube coil through which the water is forced at high velocity. In some ways it is similar to the Benson, and, like the Benson, eliminates drums and can be used for any desired pressure. Of particular interest right now is the unit installed in March in the 16,000-ton *S.S. Kertosono,* Rotterdam Lloyd (Holland). This is the first high-pressure "top" ever installed in a Dutch ship.

As built in 1922, the *Kertosono* generated steam at 200 lb. (saturated) in five Scotch boilers, serving three turbines ("triple-expansion") geared to a single-propeller shaft. One Scotch boiler was removed to make space for the Sulzer unit, the other four being left in for standby and emergency. The old boilers were coal-fired; the Sulzer is oil-fired. The old plant developed 4,500 s.h.p., with propeller shaft turning at 90 r.p.m. The ship made 13 knots. The present "topped" plant (with old boilers shut down), performs as follows: 5,800 s.hp., 15 knots, propeller shaft turning at 100 r.p.m. Present steam conditions are 900 lb. and 710 deg. The arrangement of units is shown diagrammatically in Fig. 4. Note that steam is now expanded through four turbines in series.

I have just learned that the *Kertosono* has completed her first outward voyage to the Dutch East Indies, always on time and without developing any trouble. Another recent Sulzer monotube installation, a 1,600-lb. "top" will soon be made in Wales by the British Colliery Co., Powell Duffryn.

With unforgettable memories of Germany, Czechoslovakia, Austria and Switzerland, I entrained at Zurich for Paris on the afternoon of March 23, arriving there the same evening. Next month's concluding installment of these rambles will tell what I learned in France and England.

Boiler Room Procedure FOR SAFE OPERATION

Operators in the Wrought Washer Mfg. Co. power plant are given the rules in this and a succeeding article for safety

By Eugene Caldwell

General Manager
Wrought Washer Mfg. Co.,
Milwaukee, Wis.

IN MANY cases when accidents occur in a plant there is a controversy over whether or not the injured employee was properly instructed in the use of the equipment involved. Even before Workmen's Compensation laws, now in force in most states, common law imposed upon the manufacturer not only the duty to provide safe working conditions but also he had to establish adequate rules for the operation of his plant.

Realizing that in the past our safety rules and instructions had simply been a matter of verbal directions, we decided to set down on paper definite procedures for operating the various departments of our plant. Inasmuch as we present a complete copy of the rules to each employee involved, and (after allowing a reasonable time for reading) require them to sign a statement that they have read the rules and agree to abide by them, there will never be any verbal testimony relative to whether the employee was given proper instructions.

Credit should be given to the U. S. Steel Corp., whose very complete and comprehensive books on safety orders suggested many of the rules. However, they were re-written and new ones added to fit our smaller plant.

The rules applying to the boiler room are as follows:

1. Care of Safety Valves

(a) All safety valves on boilers in regular service should be tried at least once every 24 hr. by easing them gently from their seats. This practice should be followed regularly to insure the valves always being free to operate.

2. Water Columns and Try-Cocks

(a) Water columns shall be blown out perfectly at least twice every 12 hr. If a gage glass is fouled internally so that the water level is not clearly visible, the glass should be cleaned or replaced. If the fouling occurs frequently, it is due to some characteristic of the water, such as suspended matter, scale solvents, lubricating oils, etc., for which a remedy should be found.

(b) Try-cocks shall be used at least twice every 12 hr. It is important that these cocks be kept in good condition, and their regular use is necessary to insure this.

3. Stop Valve Stems

(a) Rising stems of valves should not be permitted to become rusty or covered with dirt, so that they can be readily moved the full extent of their travel. A periodic inspection of all valves, stems, etc., in all the main piping systems should be made at least once a month.

(b) Great care should be exercised in using a wrench or bar in opening or closing a valve. The abuse of this means of facilitating the handling of valves may result in damage to seats, threads, stems, etc., and under some circumstances may bring about dangerous conditions.

4. Leaks in Parts Under Pressure

(a) If for any reason, such as blowing out of gaskets, vibration, over-straining of pipes, or general deterioration, the joints of steam pipes develop objectionable leaks, the application of wrenches to bolts of such joints while under steam pressure should be absolutely prohibited. If the joints are to be repaired, it should be done after the pressure has been removed from the particular section where the trouble occurs, by closing the proper valve.

(b) If the tubes of a fire-tube boiler develop leaks at the tube sheet, expanders should not be applied to the ends of the tubes while the boiler is under pressure.

(c) If a leaks develops at any part of the sections of a boiler, whether in the cast-steel headers to which the tubes are attached, or at a riveted joint, the use of a calking tool to stop this leak while the structure is under pressure should be prohibited.

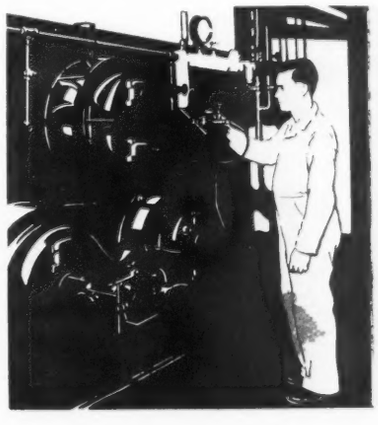
(d) If a leak develops at a hand-hole plate or around the tube caps of water-tube boilers, they should not be stopped by tightening up the bolts while steam pressure is on the boiler.

(e) If a leak develops at a manhole cover, it should not be repaired while the boiler is under steam, by tightening the bolts in the yoke.

5. Steam Piping

(a) Before breaking any steam - pipe joints to make repairs, renew gaskets, etc., the dead section should be well drained —to avoid danger of scalding by steam or water in the pipe.

(b) Steam should be admitted to cold piping very slowly.



(c) If a portion of piping has remained unused for an hour or more, it is important that a complete drainage has been secured previous to turning steam into it. This precaution should be in addition to that ordinarily provided by the use of traps or steam separators, which are usually located near the engines.

6. Starting Fires in a Cold Boiler Setting

If a boiler has been out of use for sufficient time to permit all parts of the setting to become cold or if it is a new boiler just being put into service (in either case the boiler being one of a battery, a part of which is in service), the following method of procedure is advised:

(a) Make sure that all workmen are out of the boiler and setting, and that all manhole covers or other parts are properly in place.

(b) See that the stop valve between the "goose neck" and header is tight, and that the drain pipes in the "goose neck" are open; also that the drain valve under the non-return valve (if such is in use) is open, and that the connection to the steam gage is open and in good condition.

(c) Open the feed valve and fill the boiler gradually, until the water level stands between the first and second gages of the water column.

(d) Start a light wood fire in the furnace and have the stack damper practically closed. The escape of smoke, under such condition, from the setting, will indicate any air leaks, unclosed doors, or other defects. If any such leaks are observed they should be corrected before proceeding further.

(e) Continue the firing, with gradual increase of fuel (the damper being adjusted to the requirements), until all air is driven from the boiler and steam is escaping from the drain pipe of the water column, or from any other small pipe connection in the boiler which is open.

(f) In a period of at least two hours, the steam pressure in the boiler should be brought up practically to that of the pressure in header (though, of course, if the boilers are new, a much longer time should be taken.)

(g) Before firing the boiler to take its share of the load, lift the lever on the safety valve to see that it is free to act and observe at the earliest opportunity whether this valve lifts at the allowed pressure of the boiler, or under that pressure.

(h) The stop valve in the feedwater pipe near the feed main of the boiler house should now be wide open, also the stop valve between the check valve and the boiler; the feed-controlling valve should be adjusted by the water tender to an opening such as will provide the required water delivery, and the automatic level regulating system placed in operation.

7. Checking Fires

(a) The practice of checking fires by opening fire doors, so as to permit an inrush of great quantities of cold air into the boiler setting and stack, is bad economy and is attended by more or less danger, due to the rapid change of temperature of the boiler and setting structure.

(b) As an alternative to this, it is strongly advised that fires should be checked by means of the dampers, thus interrupting the flow of hot gas from the boiler setting.

8. Blowing Out Boilers

(a) The bottom blow-off in boilers should be used at least once every 12 hr., the valves in the blow-off connections being left open for a period of from $\frac{1}{2}$ to $1\frac{1}{2}$ min., in accordance with the character of the feedwater supply. If the water is badly contaminated by scale-forming material, the longer period for blow-off is recommended.

(b) Before blowing down a boiler, first open the blow-off valve next to the boiler slowly. Second, open the valve next to the blow-off line slowly. When closing these valves, close the valve next to the blow-off line first, then close the valve next to the boiler.

(c) A boiler should not be emptied until the setting has cooled.

9. Laying Off Boilers

When a boiler is to be taken out of service for cleaning, etc., the following procedure should be observed:

(a) Check the dampers and allow the fires to burn out, at which time the non-return valve will be seated; also close the gate valve in the branch next to the header, and open the drains in the "goose neck."

(b) Shut off the stop valves in the feed system.

(c) Open the dampers wide and allow the steam pressure to fall as a result of the heat absorbed by the air passing through the setting and boiler into the stack.

(d) After the boiler is cooled, the blow-off valves may be opened and water allowed to flow out of the boiler.

10. Cleaning Boilers

(a) Preparatory to cleaning or inspecting a boiler, and as soon as it has been taken off the line, the following precautions should be observed:

Place on the stop-valve handle on the blow-off valve, and on the feed stop valve, an approved safety tag which locks these valves closed.

(b) Open escape pipe on steam nozzle, or water column drain pipe valve, so as to make sure that there is no pressure remaining in the boiler. Manhole covers may be then taken off and the boiler opened up for cleaning. It should be an invariable rule that the man who enters a boiler for the purpose of cleaning or inspection should install the safety tags on the above mentioned valves and he must give the final assent for the return of the manhole covers to their places and removal of the tags.

(c) Previous to entering a boiler, it is advisable to determine whether there is any gas or bad air present by passing a torch or candle attached to a long handle, inside.

11. Cleaning Boiler Settings:

(a) Dampers and doors should be left open while men are inside setting, so as to maintain a circulation of air.

(b) Except for testing, electric lights only should be used in making repairs on boilers or settings.

ROLLER GUIDES
Save Elevator Power

GUIDE-RAIL lubrication has always been one of the most troublesome elevator-maintenance problems. The lubricant is difficult to apply satisfactorily under all conditions, creates a fire hazard, and makes it almost impossible to keep the hoistway outside of the car clean. Development of ball-bearing roller-type guides promises to solve these problems.

The photographs show the design of a roller guide developed by the Elevator Guide Corp., and approved by the Board of Builders, New York, N. Y. Six rubber-tired disk wheels, 6-in. in diameter, comprise the guide element. Solid-rubber tires having a consistency similar to that of automobile tires, are vulcanized onto steel rims which run on ball bearings. The six wheels are supported on the ends of three arms and the assembly carried on a free-moving graphited trunnion in the top of the guide-bracket support. A thick rubber washer *A* between the supporting bracket and guide assembly provides flexibility in the mounting. Arms supporting the rolls against the two rail sides are also flexibly mounted, being held against soft-rubber washers *B* by spring tension. The amount of flexibility allowed depends upon the safety-jaw clearance. This mounting holds the rollers to the rails and absorbs shocks from unequal loading in the car and faulty rail alignment.

Before installing the roller guides, the car and counterweight guides and rails are thoroughly cleaned, first by washing with kerosene, then with carbon tetrachloride. Then, the old shoes are removed, the roller guides bolted in their place, and adjusted to hold all rollers in contact with the rails under considerable pressure, when the car is balanced in the hoistway.

Over 20 installations of these guides have been made on both high-rise express and low-rise local cars, operating at speeds up to 1,200 ft. per min. They operate quietly and give the car smooth-riding qualities, even when the rails are in poor alignment. None of the installations have been in service long enough to determine the life of the rubber tires. They are guaranteed for 50,000 mi.

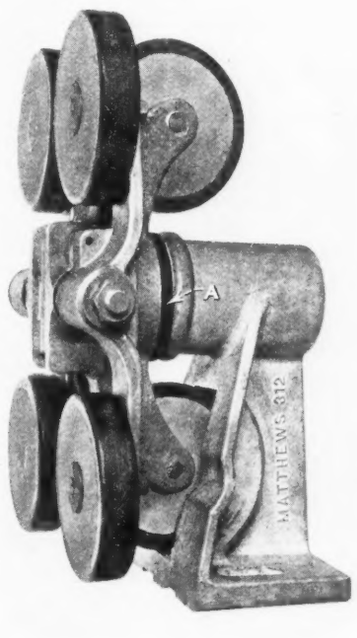
Power saving with the roller-guide shoes will vary with conditions, but in some installations has reached 33%. It will be a maximum on high-rise express cars operating on poor rails with inadequate lubrication and will be a minimum on low-rise local cars with good rails and lubrication.

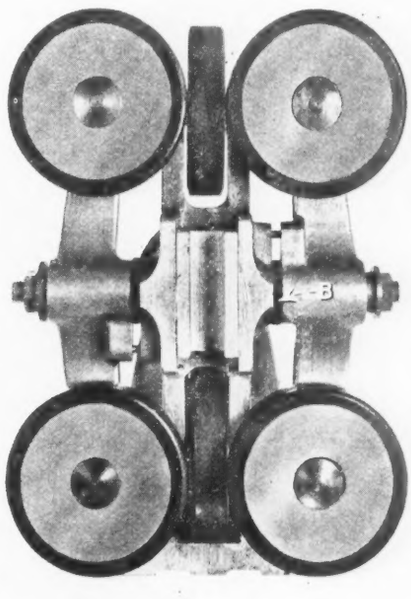
The large reduction in friction is very evident when stopping the car at the floors. With lubricated rails and guide shoes, the car is not nearly as sensitive to poor brake adjustments as when roller guides are used. With the former, the friction between the guides and rails act as a dashpot to absorb some of the shock resulting from improper brake adjustments, while the car with roller guides, in its vertical motion, acts as a free body.

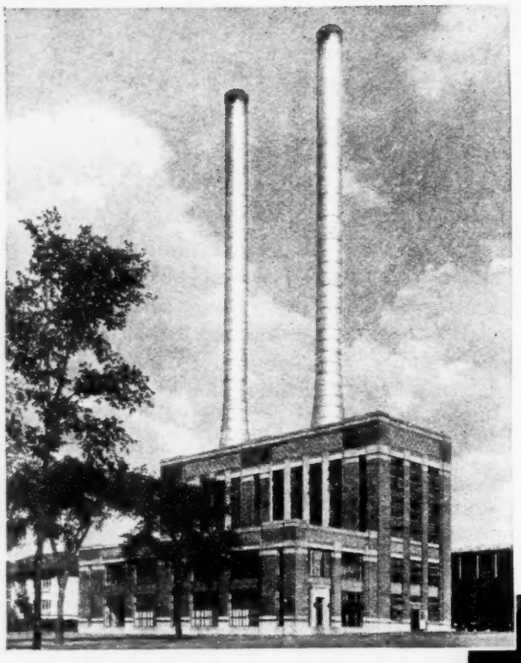
Operating with dry guide rails and using fire-resisting traveling cables make the hoistway equipment practically fireproof. Reports on this hazard indicate that it is more serious than generally believed.

There is also a saving in lubrication cost and maintenance in the hoistway. Because of the guide rail lubricant, particularly on high-speed elevators, it has been practically impossible to maintain a clean hoistway and car. If the guide rails are operated dry, the hoistway and outside of the car can be thoroughly cleaned of all oil and dirt, painted and then maintained clean by vacuum cleaning. In one building where roller guides have been installed, a portable vacuum cleaner has been purchased to clean periodically the hoistway and outside of the car.

A question naturally arises as to how the car safeties operate on dry rails. Tests have shown that there is little difference than when the rails are lubricated. Probably the lubricant was never as effective a cushion as it was thought to be. First, the high pressure of the safety jaws on the rails squeezed out the lubricant, and the high temperatures due to friction at the points of contact burned out what little that might have remained.







Ford "TOPS" AT WINDSOR

Two 825-lb. gage, 165,000-lb. per hr. boilers and 25,000-kw. in turbines to go into Canadian plant

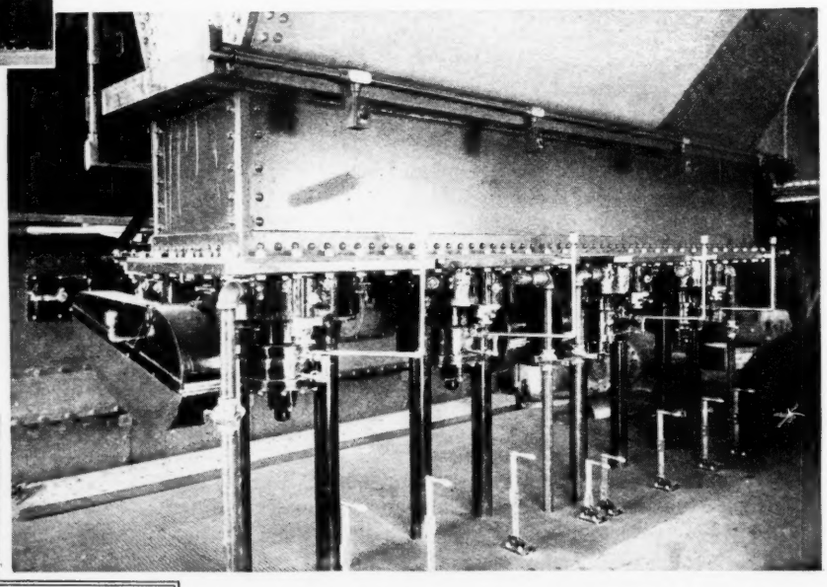
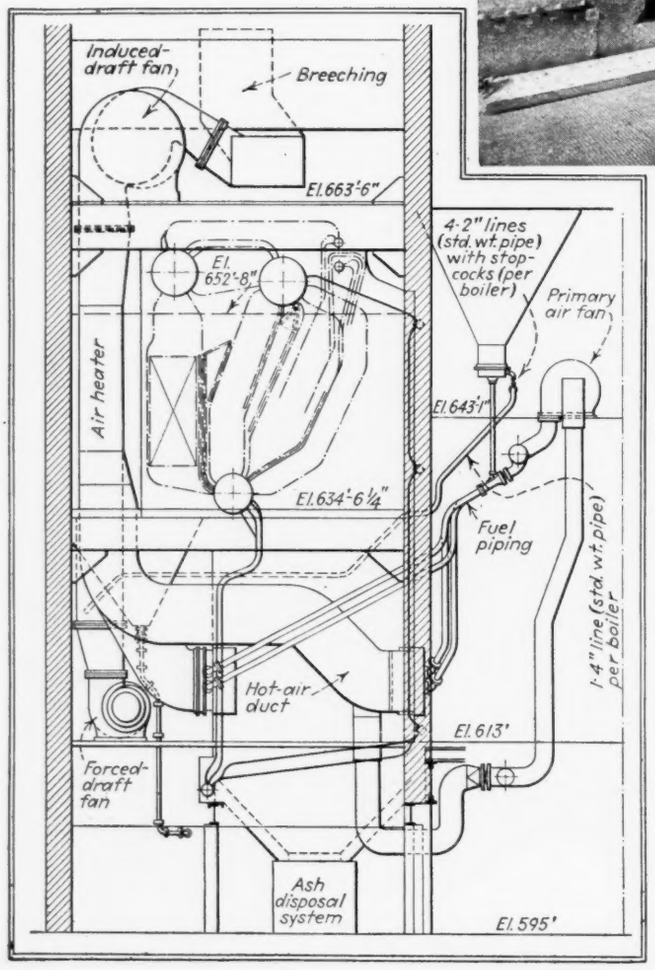


Fig. 1 (Above)—This 15,000-kw. station is increasing pressure to 800 lb. and capacity to 35,000 kw. Fig. 2 (Right)—Pulverized-coal bunker and coal feeder mechanism in front of new boiler No. 4. Fig. 3 (Below)—Boiler and duct arrangement. Note primary air bled from hot-air duct



FORD Motor Company of Canada, Limited, Windsor, Ontario, is "topping" its power plant by installing two new boilers and three new turbines. The original power plant contained three 110,000-lb. per-hr. boilers (space provided for four) and one 5,000-and one 10,000-kw. turbo-generators. Steam was generated at 200 lb. gage and superheated to 600 deg. for the turbines and for heating and process. As is customary with Ford, the plant is an imposing brick structure set well back on a landscaped area, and the interior is finished in brick, tile and chromium plate. It serves the plant which last year built 80,000 Fords for Canada and the British Empire.

The new boilers are 3-drum, bent-tube, 165,000-lb. per hr. (200,000 max.) pulverized-coal-fired units supplying steam at a design temperature of 820 deg. F. and a design pressure of 900 lb. gage. Heating surface is 9,010 sq. ft. each, plus 4,325 sq. ft. in waterwalls, 4,220 sq. ft. in economizer surface and 9,940 sq. ft. in preheaters. Drums were forged in England in one piece, the 24-ton top drum being 48

in. in diameter and 3¾ in. thick. There are 595 boiler tubes (No. 4 gage, 3 in. O.D.), and 156 waterwall tubes (No. 2 gage, 3½ in. O.D.).

Most economical boiler capacity is 125,000 lb. per hr., at which rate fuel requirements are 11,270 lb. per hr. of 14,200-B.t.u. Pennsylvania and West Virginia bituminous coals. At 165,000 lb. output, 14,930 lb. of coal per hr. are required. Temperatures are:

	Temperature, Deg. F. at 125,000 lb. per hr.	at 165,000 lb. per hr.
Gases leaving economizer	535	570
Water leaving economizer	400	406
Air entering preheater	80	80
Air leaving preheater	341	355
Gas entering preheater	535	570
Gas leaving preheater	337	357

At 125,000-lb. per hr. steam delivery, 126,700 lb. of air enters the preheater, and at 165,000-lb. per hr. delivery, 173,000 lb. per hr. of air enters. Air bled from the preheater ducts is used in the coal-feeder system. Some air is also taken out to agitate the fuel in bin outlets, and hot air bled from the hot-air ducts provides primary air. The old pulverizers are used, as their capacity is sufficient to care for the new plant.

Two 600-hp. boiler feed pumps deliver 632 gal. per min. against 900 lb. per sq. in. One is driven by a 3,600-r.p.m. motor, the other by a 3,600-r.p.m. back-pressure turbine, taking steam at 200 lb. and exhausting at 7 lb. to the heating system.

Automatic combustion control and three-element feedwater regulators are used. Other boiler auxiliaries include soot blowers, forced and induced draft (vane control type) and primary air fans. All steam-lead valves and sectionalizing valves are motor operated.

A 300,000-lb. per hr. deaerating heater has been installed between the two old 200-lb. boilers and the two new ones and a 300,000 lb. per hr. closed heater directly behind it. Both are arranged for extensions to bring capacity to 500,000 lb. per hr. later, when the other two low-pressure boilers are replaced.

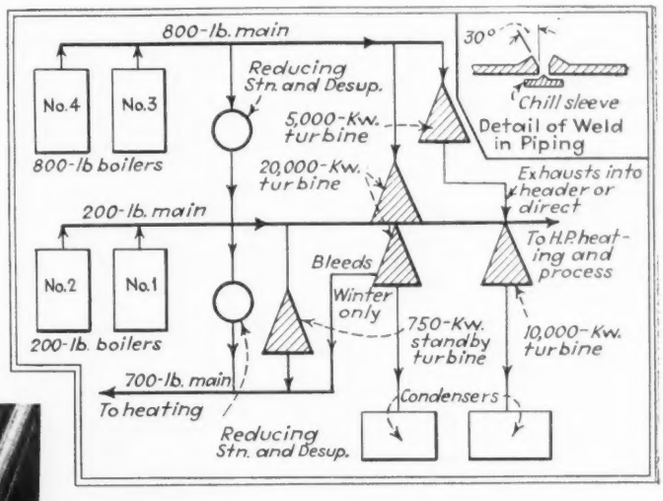
As indicated in Fig. 5, steam will reach the turbine throttle at 800 lb. and 800 deg. Reducing stations, 800 lb. to 200 lb. and 200 lb. to 7 lb. under the boilers, next to the turbine room will provide steam for all purposes if there is insufficient available from the extraction nozzles of the turbines. Pressure reducing valves are each followed by a desuperheater.

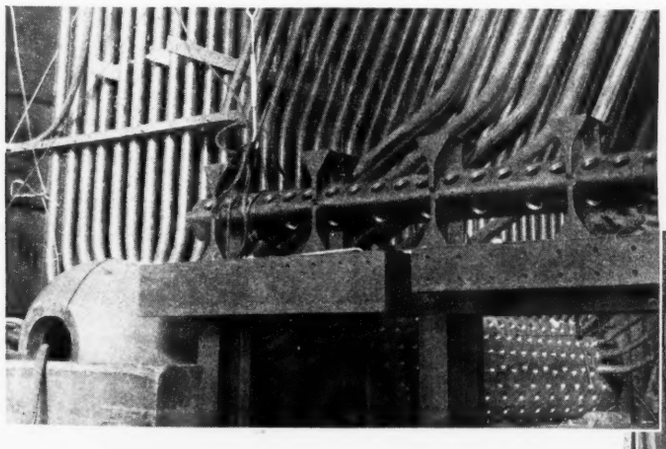
Boiler units will be enamelled and trimmed with chromium plate, even to soot blowers, valve handwheels, etc. The boiler control boards, in centre front of the boilers, are finished in black and chromium plate and have the latest type instruments.

In the turbine room the old 5,000-kw. turbo-generator will be removed to make room for the 20,000-kw. unit, the new 5,000-kw. unit being installed between the existing 5,000 and 10,000 kw. units as shown in Fig. 7.

Both the 5,000 and 20,000-kw. units are 3,600-r.p.m. machines. The 5,000-kw. is a high back-pressure type, exhausting at 200 lb. and is designed as a topping unit for the present 10,000-kw. machine. The 20,000-kw. unit is a double extraction condensing type machine with extraction at 200 lb. for process and at 7 lb. for heating.

Remaining steam from the large unit goes to a





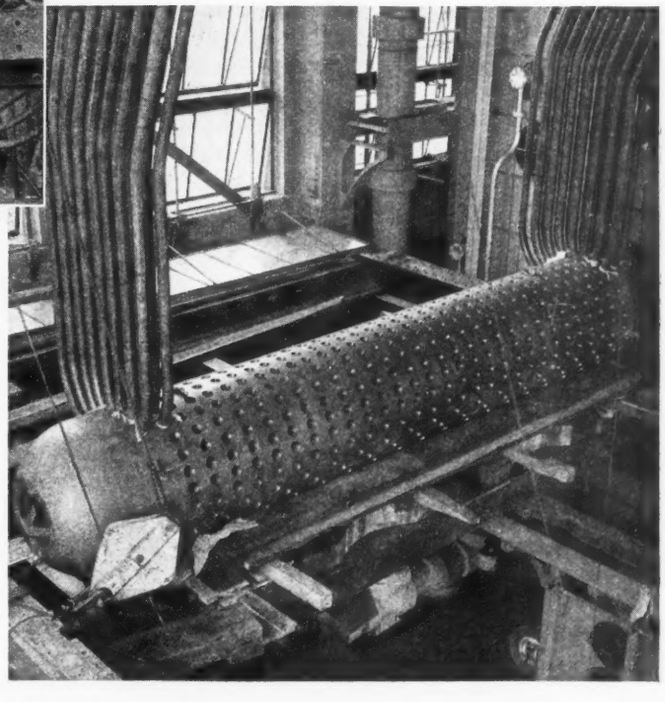


Fig. 4 (Left)—Welded waterwall header in place Fig. 5 (Above)—Plant arrangement, and at upper right, cross-section of pipe weld. Fig. 6 (Below) —Forged lower drum, showing hole spacing

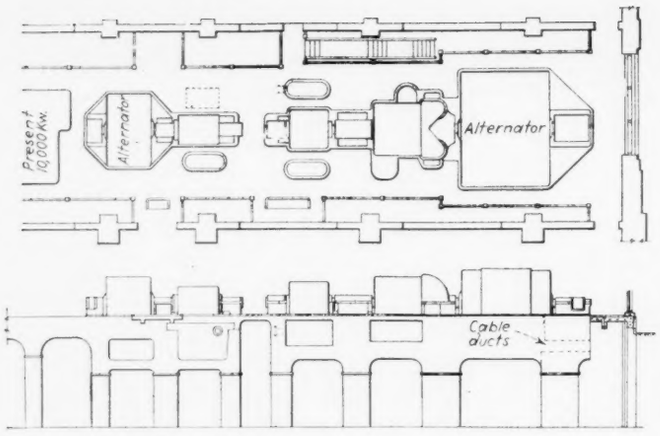


Fig. 7—Arrangement of the new turbines, which replace an old 5,000 kw. unit

condenser cooled by river water circulated by pumps.

Both new turbines drive 13,800-volt, 3-phase, 60-cycle alternators and direct-connected exciters. There will also be installed a 750-kw. standby and starting-up condensing turbine set providing 460-volt alternating current. It will not be in the turbine room proper but in the adjoining evaporator room.

This small unit is being put in now, the 5,000-kw. unit in September, and the 20,000-kw. unit in February or March of next year. The new No. 4 boiler is ready to take load, and the old No. 3 is now being removed to make room for installation of the new one, to be started early this month and completed about next February.

All piping in the station is welded, using upset-end seamless-steel pipe and chill rings, as in the cross-section of Fig. 5. The technique developed by Detroit Edison Co. is being used, preceding beads being peened before the next layer is applied and the finished weld normalized at 1,100-1,200 deg. Both gas-fired and electric resistance units are being used for normalizing, in each case consisting of a 2-part doughnut shaped element which is clamped around the joint.

The existing generating voltage of 4,600 will be tied to the new 13,800-volt buses with transformers. Eventually, all 4,600-volt equipment throughout the plant, substations and feeders will be replaced by equipment for the higher voltage. New 460-volt metal-clad switchgear is also being installed for the power house auxiliaries.

EXHAUST LINES

By E. J. Tangerman

F. E. Herr, chief engineer at the Sole & Heel plant of Brown Shoe Co., St. Louis, has a peculiar waste fuel—leather scraps. Only enough scraps are available to last half a day, so the rest of the day he burns bituminous. Though only one boiler may be needed he has to use two, because the leather creates so hot a fire that it can't be fired continually, and if fired alone it won't keep up steam.

Out at Busch-Sulzer is the largest milling machine in the world, milling blocks for trunk-piston engines, of which the 30x52-in. unit is the world's largest.

Use for old ball or roller bearings —Down in Tulsa I saw a youngster with a scooter wheeled with old bearings. A round block driven through the inner race became the axle, the outer race was the tread. Rides fast, too.

Okla. Public Service keeps the lights in the 8 show windows of its Tulsa building on day and night—42 kw. apiece. When the building was to be air-conditioned they decided to circulate outside air through the windows, removing heat from them as fast as it was formed. So they hooded the windows and drew the air heated by the light, up and out. The lights heat 3,100 c.f.m. of air from 80 to 150 deg. F. In winter the fans will be reversed, so that the windows will help heat the showroom.

With ever higher steam temperatures, detection of leaks becomes a real problem. If a man gets his hand near a leak, it will be burned to a crisp before he can pull it away. And of course the steam can't be seen until it becomes water vapor some feet away. So they hang an old piece of rag on a stick and carry it along the steam line. When the rag bursts into flame, that's your leak.

The movies, too, have their power problems, what with the tremendous lighting and power requirements necessary nowadays. Out "on location" for "Treasure Island," they had to take three complete generating plants along. Normally they're diesel-electric sets which can be taken from the ships and set up easily on shore wherever required, desert island or not.

Once a gas well is flowing, they like to keep it flowing, but demands may not remain anywhere near constant. So down in Louisiana, they're letting the gas flow into abandoned wells for gas holders. Then when demand picks up the stored gas can be pumped out.

Not so long ago, a pair of bloodhounds belonging to Troop K of the New York State Police found Grover Whalen, Jr., unconscious in a ravine near his father's estate at Dobbs Ferry, N. Y., after hundreds of human searchers had failed. There followed much ballyhoo and praise in the newspapers, capped by tales of how the bloodhounds "always get their man." That was too much for the editor of *The New Yorker*, so he went to see about it. In the course of conversation, the police captain who has charge of the dogs offered a demonstration. So the editor handed over a glove, went outside headquarters, executed a number of the devious maneuvers he'd read about that Indians do to lose a pursuer, then hid in a shed. Shortly thereafter, he peeked out to see the bloodhound and the Captain starting off after him but in a totally different direction. He went back to headquarters, where after a while the captain and bloodhound returned. It seems that this particular bloodhound had learned that the boiler-room is much more comfortable than any other place, and had been sneaking off there for naps. Glove or no glove, duty or no duty, when they let him out he started back for comfort.

On some of the old diesels, water had to be mixed with the lubricating oil to avoid oil pumping. Somebody bought one of the old engines recently, and contrary to instructions of the installer, started it up. Before he could get it shut down again, it had thrown a piston or two. Investigation showed that the lubricating oil should have been mixed in the proportion of 7quarts of oil to 20 of water, otherwise the engine starts to run on lubricating oil—and keeps on doing it.

Fairbanks Morse at Beloit always has quite a few big engines going through their paces on the test block. So the plant is powered by about 5,000 kw.—1,000 kw. of it in two permanent engines with Woodward governors, the other 4,000 in engines on test.

The new running track at Randall's Island stadium, New York City, is claimed to be the world's fastest. Like other tracks, it is made of cinders over a clay base, but its cinders are from power plants. It seems that power-plant cinders are burned harder than other kinds.

Fig. 1 — Norris Dam and power house as it appeared on May 14

NORRIS DAM Starts Power Generation

First river-regulation and power project of T.V.A., a dam with a 3,400,000-acre ft. reservoir and 132,000-hp. power-generating capacity, started operation August first

NORRIS dam (formerly Cove-Creek dam) forms one of the main storage reservoirs planned, for regulating flow and for flood protection on the Tennessee River, by the Tennessee Valley Authority. It is 20 mi. northwest of Knoxville and 80 mi. up the Clinch River from its confluence with the Tennessee. Actual construction started on this dam Nov. 7, 1933, and initial operation started August of this year. See pages 354-357, July *Power*.)

The flow of the Clinch river at the site of the dam has varied during the 30 years of record from a minimum of 200 to a maximum of approximately 115,000 c.f.s. Annual runoff has varied from 1,700,000 to 4,830,000 acre-ft., the average value being 3,300,000 acre-ft. The reservoir created by the dam, which is now filled within 25 ft. of the spillway crest, contains 550,000 acre-feet. of dead storage, above which, 1,500,000 acre-feet to spillway elevation will be utilized for power-generation and river-regulation. The remaining storage capacity, 1,350.000 acre-ft., forms a reserve for control of flood water.

Total storage is therefore 3,400,000 acre-ft. It is estimated that, during this year's spring flood, the reservoir withheld approximately 40,000 c.f.s. from the maximum flow in the Tennessee, thus reducing the crest at Chattanooga by 3 ft. and saving much property from serious damage. When entirely filled, the power-generation and river-regulation storage will about double the dry year minimum flow of the Tennessee river at Muscle Shoals, the increase being approximately 7,000 c.f.s.

Much has been said about silt, carried by the water, filling up the reservoir. Estimates made, based on double the amount of silt carried by the Tennessee River at Knoxville, show that it would take 500 yr. to fill the 500,000 acre-ft. of dead storage in the reservoir. Present and future reforestration work will to a large extent eliminate silting.

Except for a relatively short earth-fill section, with a concrete core wall at its east end, the dam is of the concrete-gravity type for its entire length of 1,872 ft., Fig. 2. A public highway runs across its top, the crown of which is 267 ft. above the lowest foundation area. Three drum gates, Fig. 4, each 14 ft. high and 100 ft. long, control the spillway crest, designed to discharge 205,000 sec.-ft. Eight sluiceways through the dam, each controlled by two hydraulically-operated sliding vertical gates placed in tandem, one for emergency and one for service use, Fig. 3, provide 37,000 sec.-ft. additional discharge capacity.

The spillway gates are an interesting feature of the dam, one of which is shown in the raised position, Fig. 4. They are hollow and watertight, made of steel plate on triangular fabricated steel ribs and hinged at their upstream corner to the crest of the spillway. Normally the gates will remain in their lowered position in the top of the spillway, their top side completing the spillway crest. During heavy floods, when it is desired to store water above normal spillway-crest level, the gates are raised by flotation, water being admitted under them. They are lowered by releasing the water from the pockets.

Because of the uncertain character of limestone rock under the dam and reservoir, very careful studies of foundation conditions and grouting were made. With the reservoir practically full, the dam and its foundation show practically no signs of leakage, and there is every reason to believe that these conditions will continue to prevail.

The power-house is located east of the spillway

just below the dam, Fig. 1. It contains two main units, the complete power installation for this plant. Each unit connects to the reservoir by a 20-ft. plate-steel penstock, embedded in the dam, at the entrance of which is a tractor-type gate, raised and lowered by a hoist at the top of the dam, Fig. 5. An 18-in. gate valve bypasses each tractor gate for filling the penstock. A gate is not provided at the turbine, that at the penstock entrance being considered sufficient for all requirements. Seats for stop-logs are provided upstream from the gates.

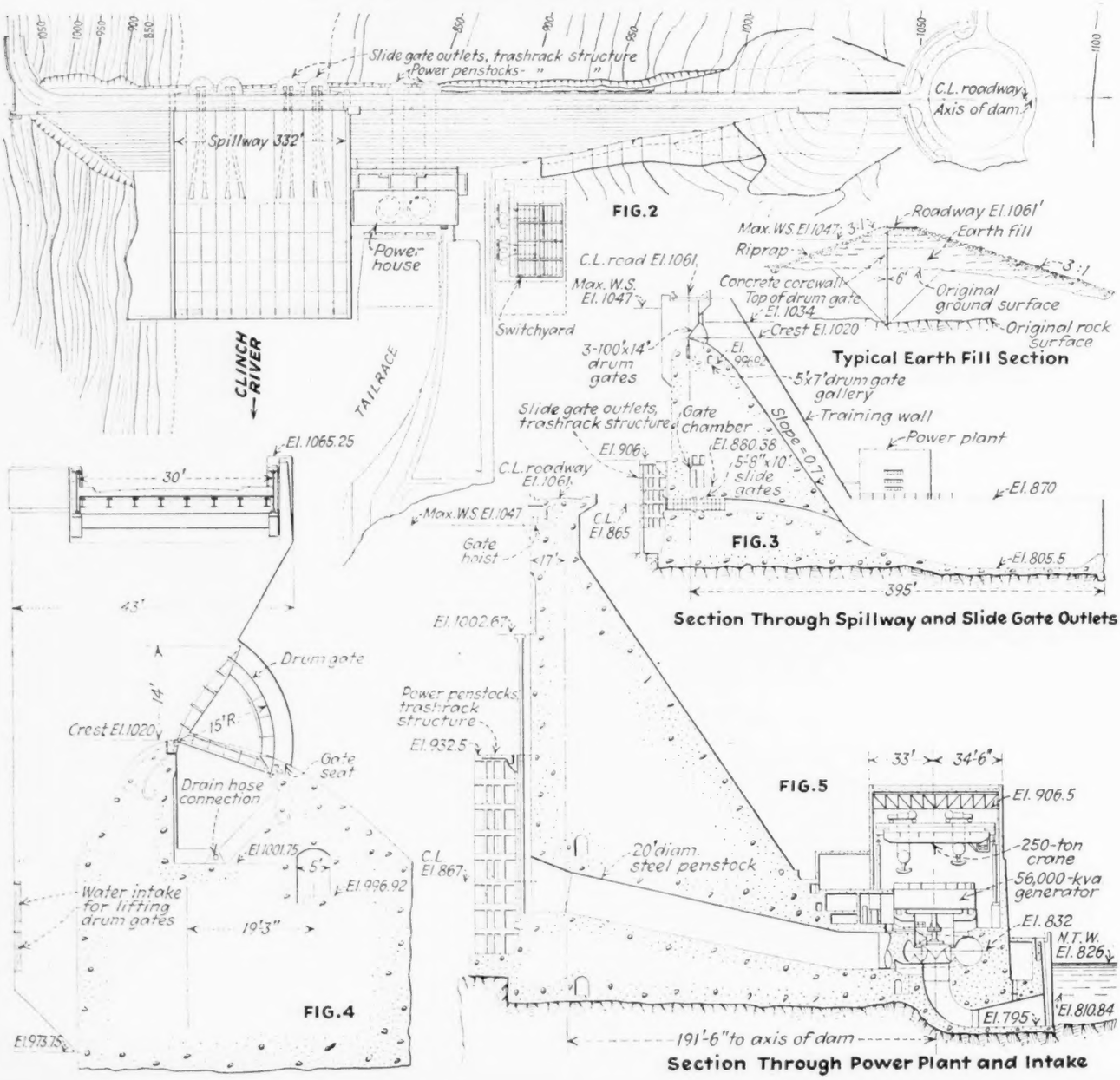
The two Newport News turbines are vertical-shaft, francis type with embedded plate-steel spiral scroll case, Fig. 5. Each is rated at 66,000 hp. under a net head of 165 ft. and normal speed of 112.5 r.p.m. Gross head on the turbine varies from about 130 to 196 ft.

The turbine-casing is of butt-riveted-type, plate-steel construction. Elbow-type draft tubes are used with two piers in their horizontal leg. Their tops are lined with $\frac{5}{8}$-in. steel plate heavily reinforced with T-bar sections and welded. The speed rings are made in four pieces, each section with three vanes cast integral. The lower part extends downward opposite the runner band to form a foundation ring. An 8-in. adjustable vacuum breaker, actuated by the gate-operating ring admits air to the center of the draft tube underneath the runner, at a predetermined gate opening.

A plate-steel baffle on the under side of the crown plate collects water on top of the runner crown that has been thrown toward its periphery by centrifugal force and guides it to the cored drain hole in the runner crown. This arrangement prevents accumulation of pressure on top of the runner crown and reduces the hydraulic thrust to a minimum.

Plate-steel wearing rings opposite the ends of the wicket gates are secured by special screws, peened and finished flush with the wearing plate. Stationary wearing rings for the runner seals are of steel made in segments and bolted to the stationary seats. One-piece rotating wearing rings are machined and shrunk onto the runner bands. Seats for the stationary rings were machined in the shop, but sufficient stock left on them to allow grinding in the field to a true circle concentric with the turbine rotating parts. Clearance

Fig. 2 to 5—Cross sections through Norris Dam and power house



between the top wearing ring is 0.04 in., and between the bottom ring 0.06 in.

The turbine runner, 14 ft. 6 in. in diameter, and 6 ft. 10 in. high, is made of cast steel in one piece, and weighs 45 tons. It is designed to support its own weight plus that of the shaft when disconnected from the generator and resting on the speed ring. With wearing rings attached the runner was statically balanced in the manufacturer's shop after chipping and machining had been completed.

Each turbine has an oil-lubricated babbitt-lined guide bearing, normally supplied with oil by an alternating-current motor-driven pump. A direct-current motor-driven oil pump, controlled by float switches and temperature relays, will come into service automatically during emergencies. A shutdown relay will stop the turbine should both oil pumps fail.

Each turbine connects to a Westinghouse umbrella-type 56,000-kva., 13,800-volt 3-phase, 60-cycle, 90% power factor generator. The generators are totally inclosed and cooled by recirculating air through coolers placed symmetrically around their frame. Their housings are practically air-tight to permit using CO_2 fire-extinguishing equipment. Automatic

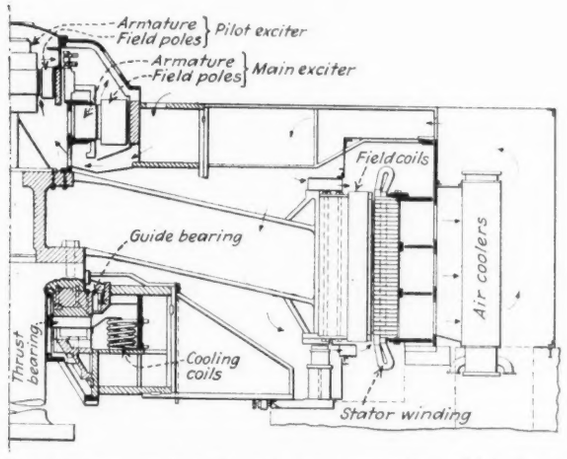


Fig. 6—Cross section through one generator, which has a telescopic exciter

brakes can stop the generator rotor in 15 min.

A reduction in overhead room of about 3.5 ft. results from using a telescope exciter design. The term telescope exciter is suggested because of the arrangment of parts. The main exciter armature is mounted on a specially designed spider bolted to the main generator rotor and the upper bracket supports its field frame, Fig. 6. The pilot-exciter armature is located inside the main-exciter rotor, with its stationary member supported on the main bracket by an auxiliary bracket.

A Kingsbury-type thrust bearing supports the entire rotating load comprising generator and turbine rotors plus hydraulic thrust. Combined with the thrust bearing is the guide bearing, Fig. 6. Guide and thrust bearing operate in a single oil bath, from which the heat is dissipated by water-cooled coils.

Each generator connects directly to a bank of three 13,200 to 89,000-volt, 18,667-kva. transformers connected delta-star to give 154,000 volts on the high-voltage side. Inside connected taps for 110,000 volts are also provided. Paralleling of the two machines is done on the high-tension bus. Two three-phase 13,200- to 480-volt, 750-kva. service transformers connect directly to the generator leads. On their low-voltage side these transformers connect through an automatic air-break circuit breaker to the auxiliary busbars, where they may be paralleled with the auxiliary transformer on the other unit.

Each generator with its main and auxiliary transformers has differential-relay protection that completely isolates the equipment in case of trouble. If the generator differential protection operates it trips the 460-volt, station-service breaker, disconnects the generator and transformers from the high-tension bus, trips the ground oil switch, opens the exciter-field circuit breaker, energizes the governor shutdown solenoid, releases CO_2 into the generator, applies the generator brakes and operates an annunciator to show where the trouble is. On the main or auxiliary transformer banks, in case of electrical faults, the differential relays perform the same functions as do the generator relays, but do not release the CO_2 into the generator or apply the brakes.

Acceptance test will be made on the units, the water flow being measured by the Gibson time-pressure method. Winter-Kennedy pressure taps will be used to obtain a pressure differential to actuate meters for indicating and recording water flow to the turbines during normal operation. One of these taps is made on the back of the scroll case on the horizontal center line, the other on top of the speed ring.

Those directly responsible for the project include A. E. Morgan, chairman and chief engineer of the Tennessee Valley Authority, Carl A. Bock, assistant chief engineer, J. S. Bowman, hydraulic engineer, R. A. Hopkins, principal electrical engineer. Barton M. Jones, construction engineer, Ross White, general superintendent of construction, F. C. Schlemmer, construction superintendent, C. H. Locker, construction consultant, and A. J. Ackerman, construction-plant engineer.

PRINCIPAL EQUIPMENT IN NORRIS DAM PLANT

Turbines	Newport News Shipbuilding & Dry Dock Co.
Governors	Woodward Governor Co.
Generators	Westinghouse Elec. & Mfg. Co.
Thrust bearings (Kingsbury type)	Westinghouse Elec. & Mfg. Co.
CO_2 fire protection	Walter Kiddie & Co., Inc.
Generator air coolers	Westinghouse Elec. & Mfg. Co.
Oil-treating equipment	De Laval Separator Co.
Oil tanks	Graver Tank & Mfg. Co.
Storage battery	Gould Storage Battery Co.
Battery-charging equipment	Electric Products Corp.
Main power transformers	General Electric Co.
House-service transformers	General Electric Co.
Small power and light transformers	Maloney Electric Co.
High-voltage circuit breakers	General Electric Co.
High-voltage disconnect switches	Electrical Eng. Equip. Co.
Air-break circuit breakers	I-T-E Circuit Breaker Co.
Main switchboards	General Electric Co.
Auxiliary switchboards	I-T-E Circuit Breaker Co.
Automatic synchronizer	General Electric Co.
Lightning Arresters	General Electric Co.
Station crane	Harnischfeger Corp.
Headwater level indicator and recorder	Leupold Volpel Co.
Tailwater level indicator and recorder	Julien P. Friez Co.
Penstock flowmeters	Bailey Meter Co.
Oil pumps	Northern Pump Co.; Schutte-Koerting Co.; Geo. D. Roper Co.
Sump pumps	Peerless Pump Co.; Aurora Pump Co.
Air compressors	Worthington Pump & Mach. Co.
Air compressors	Sullivan Machinery Co.
Electric elevator	Westinghouse Electric Elevator Co.
Air-conditioning system	York Ice & Machinery Corp.
Spillway drum gates	Virginia Bridge & Iron Co.
Spillway-gate needle valves	Koppers Constr. Co.
Spillway-gate supply valves	Chapman Valve Mfg. Co.
Sluiceway valves, and controls	Hardie Tynes Mfg. Co.
Intake tractor-type gates	Bartlett Hayward Co.
Intake gate hoists	Bartlett Hayward Co.
Pennstock bypass valves	Crane Company

SYNCHRONOUS OR INDUCTION

Compares the characteristics of synchronous and induction motors and indicates the classes of service for which each is best suited

By S. L. Henderson

Power Engineering Dept.,
Westinghouse Electric & Mfg. Co.

SYNCHRONOUS motor applications have continually broadened until now they are active competitors of induction motors on most drives. Certain drive requirements, however, distinctly call for induction motors. For instance, where variable speed is required, such as on hoist flywheel-motor-generator sets and on coal crushers, wound-rotor induction motors meet the requirements exactly. Another example is multispeed drives, sometimes used on fans. Here a squirrel-cage motor will permit as many as four separate synchronous speeds in one frame. Frequently for application in corrosive or explosive atmospheres, the choice will be a squirrel-cage induction motor because of its absence of collector rings or exciter commutators.

For applications below 100 hp., induction motors are more likely to be used than the synchronous types. For drives of these sizes the simplicity of induction motors and controls, compared to synchronous motors, is more apparent than for larger motors. The greatest competition between synchronous and induction motors is in the range above 100 hp. and 500 r.p.m. Below 500 r.p.m., the power factor of induction motors gradually gets so low as to make the synchronous motor preferable. This is evident on the curves which are for two 400-hp., 60-cycle, 2,200-volt, squirrel-cage induction motors, one operating at 1,180 r.p.m. and the other at 390 r.p.m. The power factor for the high-speed-motor is 91% at full load and 84.5 at half load. For the slow speed motor, the power factors at corresponding loads is 82 and 66% respectively.

Further discussion on the two types of motors will be confined to ratings above 100 hp. and above 500 r.p.m. Also, only 100% power-factor synchronous motors and squirrel-cage induction motors will be considered, as these two types are most nearly competitive. Obviously if an 80% power-factor synchronous motor is being considered, there is a system power factor to correct and the induction motor is non-competitive. If the drive requires variable speed or high starting torque and low kilovolt-ampere inrush, then a wound-rotor induction motor would be applied and the standard synchronous motor would not be considered.

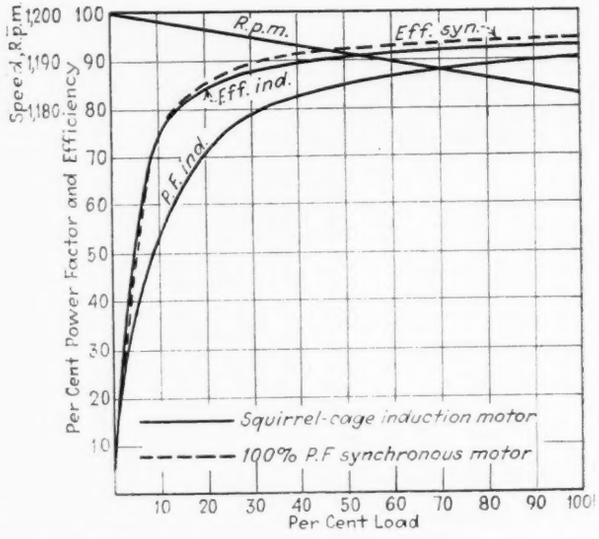
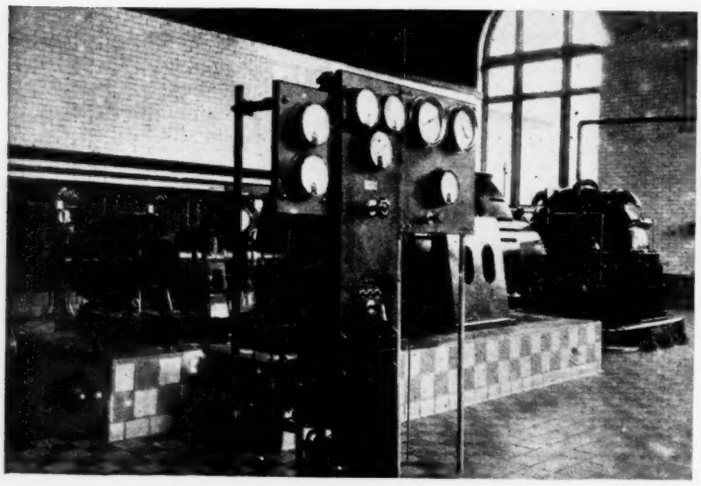
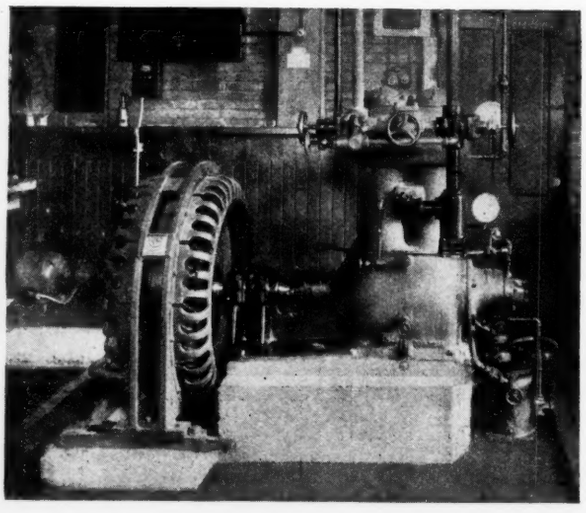


Fig. 1—Characteristic curves for a 400-hp., 3-phase, 60-cycle, 1,200-r.p.m. induction motor and efficiency of a 100% p.-f. comparable synchronous motor

Synchronous motors are inherently more efficient than induction motors for the same physical size and same grade of materials. This is more evident for low-speed motors than for high-speed machines. In both Figs. 1 and 2 it will be seen that the efficiency





Left—A 3,800-hp., 900-r.p.m. synchronous motor drives a centrifugal pump in Belmont pumping station, Philadelphia. Above—Slow-speed, 35-hp. synchronous motor drives an ammonia compressor in ice and cold-storage plant

MOTORS?

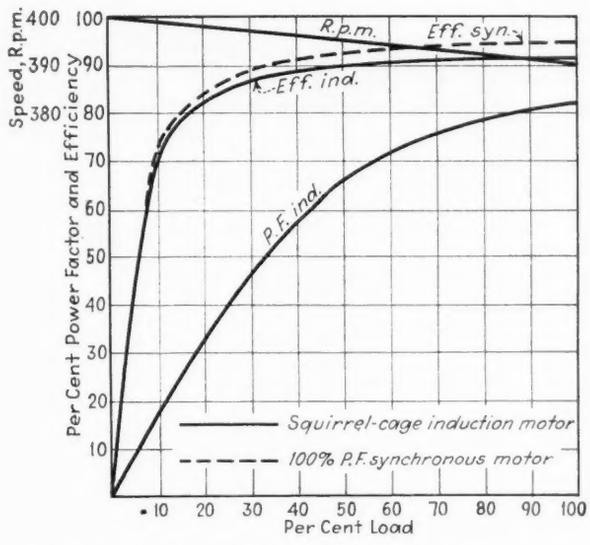
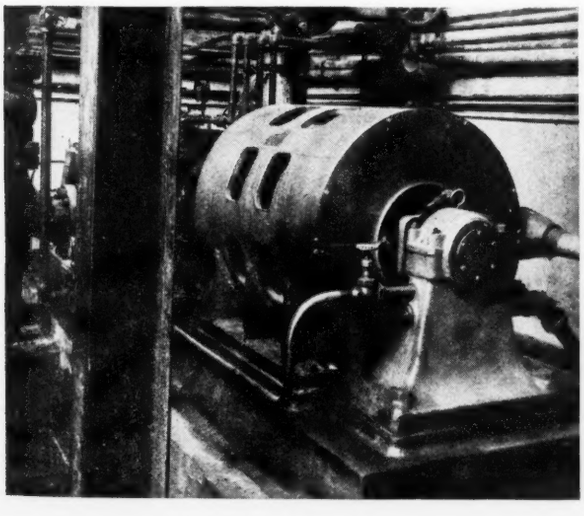


Fig. 2—Characteristic curves for a 400-hp., 3-phase, 60-cycle, 400-r.p.m. induction motor and efficiency of a 100% p.-f. comparable synchronous motor

of the synchronous motor is higher than the induction motor, but the greatest difference is for the slow-speed motor, Fig. 2. In the synchronous motor, load current is supplied to the stator and excitation provided for the rotor from separate sources. In the induction motor, excitation and load currents are both supplied to the stator and the load current is transferred across the gap to the rotor by induction. Consequently, in the induction motor there is a load current in both the stator and rotor as compared to a load current in the stator only of the synchronous motor. This means greater copper loss in the induction motor. Since the loss is greater, more cooling air is required which results in higher friction and windage loss.



Above—High-pressure boiler-feed pumps operate at high speeds. This one is driven by a 1,250-hp., 3,600-r.p.m. induction motor. Left—Two of four 200-hp., squirrel-cage induction motors driving feed-water heater pumps

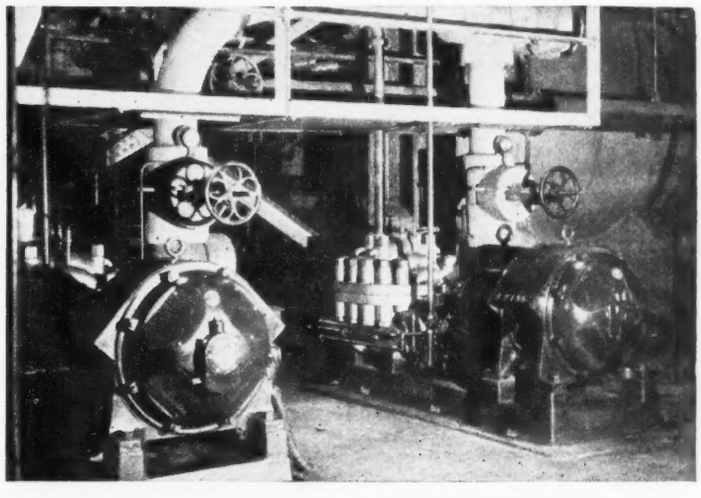
If high power factor is important then, of course, the synchronous motor will be applied; since the power factor of the induction motor will always be lagging. The lower an induction motor's speed the lower its power factor.

Because an induction motor receives its excitation and load current from the same source, the pull-out torque will vary as the square of the voltage changes. Excitation of a synchronous motor is supplied from a separate source, the exciter, and is unaffected by what happens to the line voltage. For this reason the field-pole flux remains constant and only the load current varies with voltage. Therefore, the pull-out torque of a synchronous motor varies directly as the voltage instead of as the square as for an induction motor.

Pull-in torque of a normally rated synchronous motor varies from 70% for a 514-r.p.m. motor to 100% for an 1,800-r.p.m. motor at 100% power factor. Values somewhat higher may be obtained with special-damper design. The torque at which an induction motor will pull-in is anything less than its pull-out torque which is 200% or better. This higher pull-in torque of induction motors is important on such applications as central-station auxiliaries, to reduce the time required to get back into service after a drop in station voltage.

Synchronous motors permit greater flexibility in design of their damper windings. These windings are inactive when the motors are in synchronism, therefore they can be proportioned to attain a given starting and pull-in torque without concern for normal operation. On the induction motor, however, if the resistance of the rotor winding is made high to obtain high-starting torque, then the slip and losses will be high at full load and the efficiency reduced.

A squirrel-cage-induction motor rotor construction is more simple than that of a synchronous motor which has a damper winding plus a field winding. The synchronous motor has collector rings and an exciter. In the past, synchronous motors were considered to be more likely to give trouble than induction motors. Present-day synchronous motors when given normal inspection and maintenance are as reliable as induction motors. Where normal inspection cannot be given, or conditions are bad for current collection on collectors or commutators, then the squirrel-cage induction-motor simplicity has an advantage over both synchronous and wound-rotor induction motors.



WHAT MAKES GOOD OIL GO BAD?

Two kinds of impurities accumulate in lubricating-oil systems. Here's how they get in and what you can do to keep them out. Later articles will show how to keep oil in condition and describe equipment

By James I. Clower

Asst. Professor of Machine Design
Virginia Polytechnic Institute

LUBRICATING oil cost is generally small in comparison to other operating expenses such as labor, fuel, and other supplies. Plant engineers, however, cannot afford to throw away large quantities of lubricating oils after short periods of use, nor can they afford to risk lubricating expensive machinery with dirty, contaminated oils.

All lubricating oils, regardless of the type of crude from which they are made, methods used in refining, and provisions to exclude foreign substances from the oiling system, undergo in service certain chemical and physical changes and become contaminated with foreign substances. Some oils undergo more extensive and faster chemical and physical changes than others, and some oiling systems are more effective in excluding dirt, dust, water and other contaminants from the oil. Irrespective of the original purity of the oil and effectiveness of the system in keeping out impurities, oils become unfit for service unless cleaned.

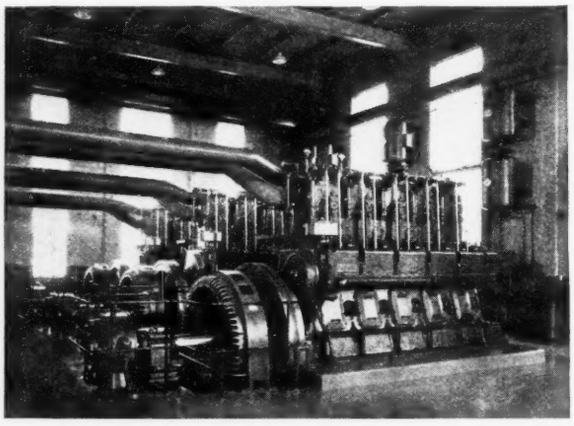
Two kinds of impurities accumulate in oil systems: One class includes substances that are extraneous or foreign to the oil. The other comprises inherent impurities chemically formed in the oil while in service. The latter also includes substances present in the crude or introduced for refining purposes and not completely removed from the finished oil.

Foreign impurities may be either solid or liquid. Solid impurities usually consist of dust and dirt from the atmosphere, carbon particles resulting from burned fuel and lubricating oil. In internal-combustion engines, grains of sand loosened by hot oil flowing through oil ducts and passages, and iron oxide as a result of corrosion of oil pipes, reservoirs, sumps, etc., find their way into the oil. Liquid impurities may be water from leaky glands or oil coolers, or moisture condensed out of the atmosphere. They may also include diluent in the case of internal-combustion engines, and various chemicals and liquors where used in manufacturing processes.

Methods of Lubricating Diesel Engines

Cylinders	Bearings
Mechanical force-feed (no oil throw)	Circulation oiling
Mechanical force-feed	Mechanical force-feed
Mechanical force-feed	Ring or drop-feed oiling
Mechanical force-feed (with oil throw)	Circulation oiling
Oil throw only	Circulation oiling
From circulation system	Circulation oiling
Splash	Splash

The accumulation of foreign impurities is independent of the original purity or quality of the oil. The extent to which they are present in the oil depends on the surrounding atmospheric conditions, design and mechanical condition of the lubricating system, and on how effective bearing seals and reservoir gaskets are in excluding dirt and water.



Regardless of the lubrication method used, diesel engines subject lubricating oil to severe service, temperatures and bearing pressures are high

Inherent impurities may be divided, according to their sources, into three general groups:

1. Crude impurities, such as sulphur compounds, which, due to incomplete refining, have not been removed from the finished oil.

2. Refining impurities, such as water, various acids, alkalies and other chemicals used in the refining processes and which have not been removed completely from the finished oil.

3. Formed impurities which consist mainly of oxidized hydro-carbons, which develop as a result of chemical reactions in the oil itself.

Obviously, the extent to which inherent impurities are present depends on the character of the crude, the refining processes, and care exercised in refining the finished oil. These impurities combine both chemically and mechanically with foreign impurities to form what is commonly called sludge. The character of sludge varies widely, depending upon both the original oil and the degree to which it has been exposed to foreign impurities. It has been proved that most foreign impurities act as catalyzers to promote oil oxidation and sludge formations. It behooves operators, therefore, to keep foreign im-

purities out of the oiling system as much as possible.

If impurities are permitted to collect, the oil becomes unfit for further use. This is not due to the oil wearing out or losing its lubricating properties as many believe, but because it becomes contaminated with detrimental impurities which are likely to clog oil ducts, holes, passages and pipes. Moreover, many solid impurities are of an abrasive character and cause excessive wear. Sludge is usually of an acid nature and if permitted to collect for any appreciable period will cause corrosion, especially to highly polished surfaces.

Removal of impurities from oil is therefore most essential if lubricating difficulties are to be avoided. It has been proved that if impurities are removed constantly or at frequent intervals the reclaimed oil is as good, and some think better, than new oil.

Steam turbines are lubricated by means of a circulation system or ring oiling, or sometimes by means of a combination of these two systems. Frequently, the oil is used over and over and continuously agitated in the presence of heat, air and usually water. These conditions are extremely favorable to oil oxidation and emulsification, especially if foreign impurities are present in appreciable quantities. Water is nearly always present and may originate from leaking shaft-packing glands; leaking water pipes in the oil cooler and moisture from air drawn into the system and cooled below its dewpoint.

Heat in the oil is generated by shearing the oil films in the bearings as well as conducted from the steam through the spindle and housing. Air is present in the bearing pedestals, the reservoir and many other points in the lubricating system. In the bearing pedestals, a constant mist of oil is sprayed from the bearing ends and intimately mixed with the air. If the return lines from bearings and governor gear discharge above the oil lever in the reservoir, air is beaten into the oil at this point. Unless the suction of the pump is kept submerged at all times, air will be drawn into the system and intimately mixed with the oil.

Solid impurities are always present in steam-turbine oiling systems. Some remain in the system after cleanings, while others enter with the air while the machine is operating. Core sand, rust and other particles of foreign material loosen by the rapid flow of hot oil through the pipes, ducts and passages and are circulated with the oil unless effective screens are provided.

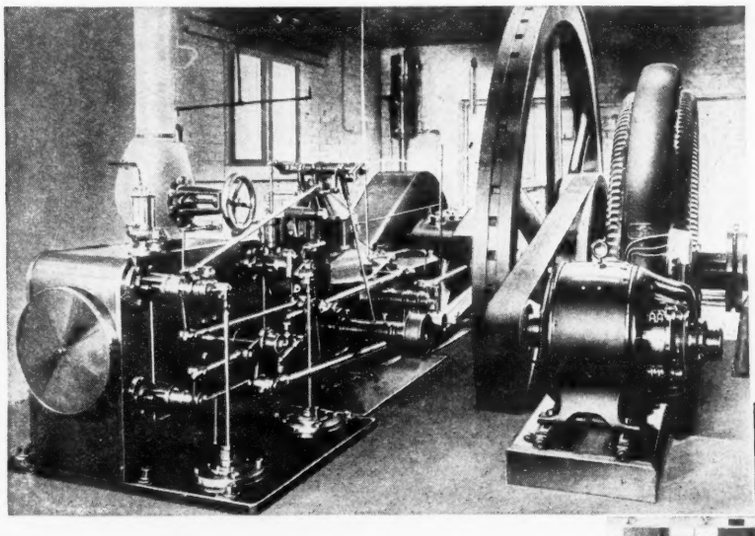
Impurities, coupled with the effect of heat, rapid circulation and aeration cause the oil to oxidize with resulting sludge and emulsion formations. Sludge usually coats oil-cooler tubes and restricts the flow through the piping, passages and ducts. This reduces cooler effectiveness and causes an increase in oil operating temperature which in turn increases the rate of oil oxidation and sludging.

Where compounded oils are used for lubricating the cylinders of steam engines it is very difficult to reclaim the cylinder oil. Equipment required is expensive and the quantity of oil used is relatively small, so that it usually does not pay to reclaim it. On the other hand, a considerable quantity of oil is used for the main bearings, crosshead and crank-pin bearings, which can be reclaimed without much difficulty.

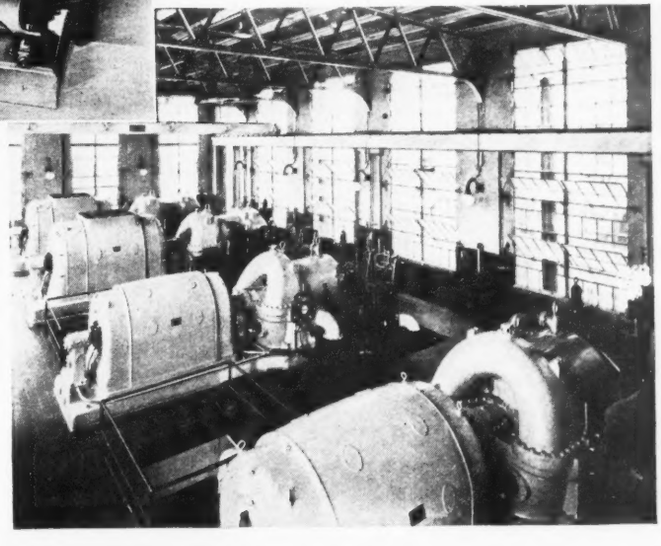
External parts of steam engines may be lubricated by any one of several methods or by a combination of two or more. Methods commonly used are drop-feed, wick-feed, splash; force-feed circulation; combination splash and drop-feed, and combination splash and force feed.

Regardless of the oiling method, foreign matter, especially water and sludge, collect in the crankcase sump. Most of the water comes from steam leakage through the piston and valve-stem stuffing boxes and subsequently condensed. A small amount may be condensed atmospheric moisture.

Solid impurities are always present and consist of rust, atmospheric dust and dirt, metal particles and other substances. When boiler feedwater is treated, chemicals used for this purpose may be carried over



Left—Steam-engine lubrication oil may become contaminated with rust, dust and dirt, metal particles, water, boiler-water chemicals and other substances



Below—Conditions under which steam-turbine lubricating oil is used are favorable for oxidation and emulsification

with the steam, then through leaky glands find their way into the crankcase oil. Where such conditions exist the task of reclaiming the oil becomes more difficult and expensive.

Methods of lubricating diesel engines vary widely as shown in the table. Regardless of the method of lubrication, diesel engines impose severe service on the lubricating oil. Temperatures and bearing pressures are high. In designs that employ oil-cooled pistons, the lubricating oil is not only required to act as lubrication but also cools the pistons. In such cases, the oil is subjected to the intense heat of the piston top, which frequently causes cracking of the oil. In most cases, blowby occurs which contaminates the oil with exhaust products, such as sulphur compounds, water, carbon, carbon dioxide, and other gases. Where water-cooled pistons are used, water leaks are common and considerable water may find its way into the lubricating oil.

These impurities, plus the heat and rapid circulation and splashing of the oil, promote oxidation and sludging. It is obviously desirable to remove the contaminations constantly or at frequent intervals.

Methods employed for lubricating air compressors are similar to those used for steam and diesel engines. The service, however, is not so severe. Temperatures are generally lower and the oil is not exposed to steam or products of combustion. Consequently the rate of oil deterioration is lower than for steam and diesel engines. Purification is necessary, however, because of the gradual accumulation of atmospheric dust, dirt, rust and other substances.

For lubricating refrigerating compressors, mechanical force-feed lubricators are generally employed to supply the cylinders of horizontal, double-acting compressors, although special drop-feed cups are sometimes used. The splash-system is most commonly used for vertical, single-acting compressors.

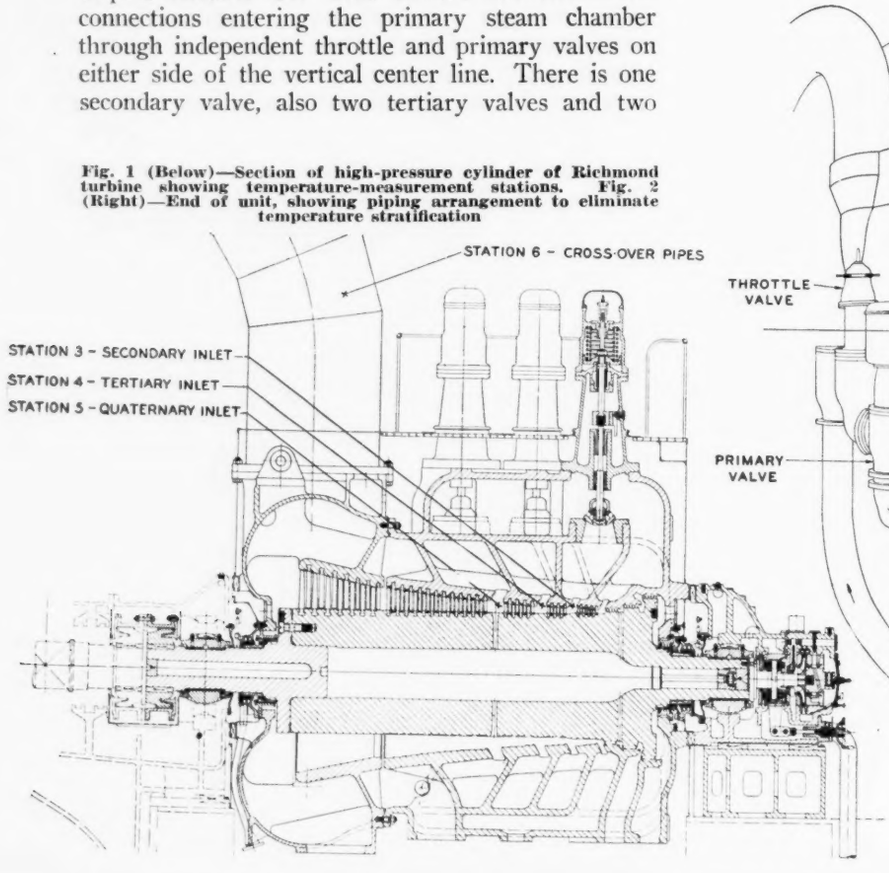
Refrigerating compressors are similar to air compressors, except the added factor of the refrigerant. It is impossible to keep the lubricating oil entirely away from the refrigerant, which generally has a harmful effect on the oil. Anhydrous ammonia has no effect, but in the presence of moisture it forms ammonium hydroxide and causes sludging. Carbon-dioxide has practically no effect on oil, but because of the low temperatures encountered an especially fluid oil is required. Both Freon and methyl-chloride dilute the oil considerably, reducing its viscosity. Sulphur-dioxide in the presence of water forms sulphurous acid, which may cause severe corrosion. Further, sulphur-dioxide combines with the color bearing material of oils and forms sludge. For this reason, only white oils should be used.

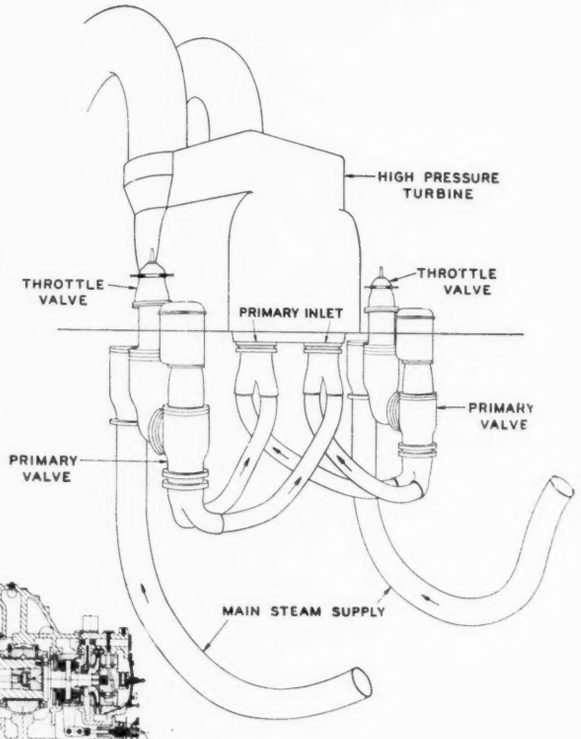
STEAM TEMPERATURE DISTRIBUTION

By N. E. Funk
Philadelphia Electric Co.

IN SEPTEMBER, 1935, a new Westinghouse 165,000-kw. tandem-compound turbo-generator was put in service in the Richmond Station of the Philadelphia Electric Co. This turbine has two steam connections entering the primary steam chamber through independent throttle and primary valves on either side of the vertical center line. There is one secondary valve, also two tertiary valves and two

Fig. 1 (Below)—Section of high-pressure cylinder of Richmond turbine showing temperature-measurement stations. Fig. 2 (Right)—End of unit, showing piping arrangement to eliminate temperature stratification





quaternary valves, all on top of the turbine, Fig. 1.

The turbine operates with steam at 400 lb. per sq. in. and an average temperature of 825 deg. At present, the turbine is served by two 600,000-lb. per hr. boilers installed to develop a maximum capacity in the turbo-generator of 135,000 kw. Additional steaming capacity necessary to develop the full turbine output will later be supplied from a third boiler and in emergency can now be secured through additional steam supplied from older boilers in the plant where the maximum steam temperature is 725 deg. F. Steam from the two new boilers and the old boilers enters a short stub header at the dividing wall between the boiler and turbine rooms. From the stub header, two separate 24-in. steam lines extend to the turbine throttle valves. When the installation was made, neither the manufacturers nor the purchaser had given sufficient consideration to the possible damage from distortion of the turbine resulting from excessive temperature difference in the two steam mains. During the preliminary period of operation when steam from the two throttle valves was not mixed prior to its entrance into the primary chamber, the possibility of trouble resulting from unequal steam-inlet temperatures was realized. As a result, the piping arrangement shown in Fig. 2 was installed where half of the steam from one throttle valve enters each of the two connection nozzles.

Reference to the table, which gives the temperatures at the throttles and inside the turbine casing at several points, before and after the inlet pipe changes, illustrates clearly the fact that the temperature differences which occur at the primary chamber extend in somewhat reduced measure well through the stages and that any extreme differences could readily result in considerable casing distortion. The only reason that the temperature differences at the throttles were not greater than shown before the inlet-pipe changes is that the boilers were carefully operated to maintain a minimum temperature difference in the leaving steam. The permissible temperature variation during that period before inlet-pipe changes were made was set at 40 deg., although the actual maximum in the table is 52 deg.

After the inlet pipes had been changed, no effort was made to maintain equal temperatures at the throttle valves and it will be noted that at a load of 94,000 kw. a temperature difference of 102 deg. was found at the throttles with no temperature difference at Station 2, entrance to the primary chamber. Temperature differences throughout the turbine at all loads were within safe limits with the altered piping.

From the experience outlined above it is evident that turbine manufacturers and utility engineers should provide equal steam-temperature distribution to turbines with dual connections.

IN 165,000-KW. RICHMOND TURBINE

STEAM TEMPERATURES IN TURBINE BEFORE AND AFTER ALTERATIONS TO STEAM INLET PIPING

"R" DESIGNATES RIGHT SIDE OF TURBINE "L" DESIGNATES LEFT SIDE OF TURBINE

BEFORE INLET PIPE CHANGES

KW. LOAD	STATION 1		STATION 2		STATION 3		STATION 4		STATION 5		STATION 6	
	R	L	R	L	R	L	R	L	R	L	R	L
0	802	796			634	621	563	561	487	485	198	196
11000	795	784			641	632	578	573	496	494	169	169
19000	806	798			682	674	618	614	534	534	189	188
40000	836	827			728	724	666	668	585	583	200	198
60000	848	813			744	722	677	664	590	585	214	218
75000	816	854			725	752	664	678	582	589	223	226
84000	855	837			795	786	746	739	644	640	253	258
90000	806	858			774	790	724	730	635	638	245	247
116000	848	822			848	840	792	789	710	706	308	306
128000	846	842			840	840	810	810	725	725	312	314

AFTER INLET PIPE CHANGES

KW. LOAD	STATION 1		STATION 2		STATION 3		STATION 4		STATION 5		STATION 6	
	R	L	R	L	R	L	R	L	R	L	R	L
0	727	733	695	697	631	632	581	574	520	519	217	217
12000	769	768	739	736	667	667	611	611	543	541	228	228
22000	769	770	751	752	653	653	597	598	529	530	210	209
40000	817	819	806	804	711	711	650	652	569	569	192	192
56000	783	769	763	767	677	678	660	660	539	538	206	205
82000	805	807	805	807	716	715	655	656	577	577	224	224
94000	725	827	784	784	725	725	681	682	593	592	231	231
110000	841	819	824	824	806	804	781	781	752	752	311	311
125000	791	827	813	816	815	815	774	774	698	699	294	294
140000	818	832	824	825	833	833	823	822	730	730	315	315
160000	840	791	821	818	824	825	818	818	779	777	333	332
172000	841	770	808	804	825	824	824	823	820	820	341	340

— KEY —

STATION 1 - THROTTLE VALVE - FIG. 2
STATION 2 - PRIMARY INLET - FIG. 2
STATION 3 - SECONDARY INLET - FIG. 1
STATION 4 - TERTIARY INLET - FIG. 1
STATION 5 - QUATERNARY INLET - FIG. 1
STATION 6 - CROSS OVER PIPES - FIG. 1

BOILER SCALE

A practical man tells, in a practical way, the fundamentals of boiler scale, its cause, prevention and cure

By Harry M. Spring
New York, N. Y.

SCALE is a coating or incrustation deposited on the water surfaces of a steam boiler by hard or impure boiler water. It may be hard and dense, or soft and porous, depending on the chemical structure, and upon physical conditions such as temperature. The heat conductivity of scale is low, varying with the density. A hard, dense scale conducts heat at a lower rate than a porous scale saturated with water.

The mineral solids found in typical samples of boiler feed water that cause scale follow in order of their importance: (1) calcium sulphate ($CaSO_4$); (2) calcium carbonate ($CaCO_3$); (3) calcium bicarbonate [$Ca(HCO_3)_2$]; (4) magnesium carbonate ($MgCO_3$); (5) magnesium bicarbonate [$Mg(HCO_3)_2$]; (6) magnesium chloride ($MgCl_2$); (7) silica (SiO_2); (8) suspended solids—trade waste, etc. Any one, or any combination, of the first five of these elements is the most common cause of hard water.

Mineral solids, in suspension or in solution, enter the boiler with the feedwater. Although some of the solids may pass out of the boiler entrained in the steam flow, a large proportion of them remain in the boiler water. It is in this manner that the concentration of solids in the boiler water builds up to a point where scale formation progresses.

The highest safe temperature for ordinary boiler plate or tubing is around 700 deg. As long as the internal surfaces are clean, and circulation of boiler water unrestricted, the surfaces may be exposed to radiant heat of the fire over 2,500 deg. without damage. Water sweeping the metal keeps the temperature within safe limits.

As soon as scale covers a section of the heating surface, water is no longer in direct contact with the metal. Before the water can carry away heat conducted through the scale and effect a temperature balance, the external surface of the metal may attain a temperature exceeding safe limits. With high combustion rates, a layer of scale the thickness of a postcard may cause sufficient temperature rise in a boiler tube to cause failure.

Physcially, carbonate scale is usually of low density, having a granular appearance. Often, however, the carbonate crystals are bound with fine particles of other material, giving a smooth, uniform appearance. If a piece of carbonate scale is dropped into a solution of acid, carbon dioxide bubbles will come rapidly to the surface.

Silica scale is the hardest type found. The scale is most often light colored, very brittle and dense. It is not soluble in acid.

Sulphate scale is harder and denser than carbonate scale, but not as dense as the silica. It is also more brittle than carbonate scale. If dropped in concentrated sulphuric acid, it will not effervesce, but if the acid is heated, the scale will dissolve.

Organic scale formed by oil, sewage, trade wastes, or vegetable matter is usually dark colored, often brown. It is very light in weight, of low density, and it will often burn if ignited. It is usually soluble in strong nitric acid.

Three possibilities present themselves as methods for scale removal; namely, mechanical, chemical, and feedwater treating.

The first method may be used where a boiler is moderately scaled, and the surfaces are accessible for mechanical scale-removing devices. Scale is cut or broken from the tubes by rotating gear cutters, or "rattlers," known as tube turbines. These are attached to a flexible hose and are slowly fed through each tube by hand. Power for the rotating action is supplied by steam, air, or water pressure.

Chemical Removal

A less tedious method, and one used to advantage where scale is heavy, and where surfaces are inaccessible for mechanical devices, is the second mentioned—chemical removal. A satisfactory method consists of dissolving in the boiler water about 75 lb. of caustic soda for each 1,000 gal. of water in the boiler. Water level in the boiler should be high enough to submerge all scale covered surfaces. The boiler is vented to atmosphere during the entire treatment, and a slow fire maintained to keep the solution boiling. This boiling should continue for about 24 hr. After cooling the boiler, it is drained, and all manhole and handhole plates, and washout plugs removed. Most of the scale should be found loosened or disintegrated.

Kerosene is sometimes used to advantage for scale removal. With this method, about 5 gal. of kerosene or coal oil are poured into an empty boiler. The feedwater valve is cracked open, and the boiler is allowed to fill slowly to normal water level taking at least 8 to 10 hr. Kerosene, floating on top of the water, tends to penetrate the scale coating, saturating it as the water rises. When the water level reaches its operating point, a slow fire is started. Steam pressure should be controlled carefully, venting the boiler if necessary, so as not to exceed about 5 lb. pressure. After several hours the fire is put out, and as soon as the boiler and setting have cooled to a safe point, the boiler is blown empty. The setting should be quite warm, but not hot enough to cause damage. The kerosene that has penetrated the scale coating tends to vaporize and break up the scale.

The third method, scale prevention by feedwater treatment, is so closely allied that it is included in this discussion.

Scale will be prevented by feeding chemically and physically pure water to a boiler. Unfortunately,

this pure water is difficult and expensive to obtain in quantities sufficient for boiler feeding. The usual water supply from rivers, lakes, or wells is often high in solids that cause scale formation. This water can be treated so as to give a relatively pure supply, having characteristics that limit scale formation to negligible amounts.

Treatment of feedwater may be divided into three classifications: first, treating the water before it enters the boiler; second, treatment of the water inside the boiler; third, a combination of the two.

Natural settling requires an artificial pond of sufficient capacity to allow water to remain practically quiescent about one day before use. Suspended solids settle out by gravity. Advantages include low cost, simplicity, and value in clarification of turbid waters. Disadvantages include: reduced effectiveness at low temperatures, space requirements usually necessitate outdoor location. In cold weather, therefore, more or less difficulty may be experienced in northern states.

Settling by coagulants requires a settling tank into which a floc-forming coagulant, usually alum or an aluminum salt, is fed. The coagulated matter (coagulant and suspended solids) settles to the bottom by gravity. Advantage is a reduction in space requirements over the natural settling pond due to the accelerated settling effected by the coagulant. Disadvantages include, cost of chemicals, and desirability of supervision by a chemist. Improper control of the coagulant proportions may result in increased hardness of the water, or in an increase in corrosive properties.

Water Softeners

Water softeners may be classified in many ways, and include the following types: zeolite, hot process, cold process, lime-soda, and lime-barium types. There are many advantages in the use of water softeners of the correct type for the particular installation. There are few disadvantages, with the exception of cost in some cases. The cost of a water softener—fixed charges plus operating cost—should be balanced against the cost of scale removal from boilers, loss in boiler efficiency due to scale, and possible damage by overheating to scaled boilers. In a great many instances, the balance will weigh in favor of the softening system.

An evaporator consists of a closed vessel into which raw water is fed. The water is evaporated by a steam coil in the vessel. The vapor passes through an evaporator condenser, thus supplying distilled water. Among the advantages is the fact that this method gives the purest water supply practical, when properly operated. Disadvantages point to operating costs which limit use of the evaporator to plants where the make-up is low, not over about 10%.

Although concentration control does not prevent scale formation, it limits the rate of formation so that with some conditions, no difficulty is experienced. If the concentration exceeds certain limits, the scale formation is rapid, foaming is likely, and deposits of solids are carried over by the steam to obstruct passages and damage steam using equipment. The concentration is controlled within these limits by blowing off an amount of water in proportion to the rate of evaporation. This may be blown down periodically through the regular blow-down line, or continuously through a smaller line.

Many of the boiler compounds for sale under various trade names are expensive, useless, or may cause dangerous operating conditions. A few substantiate their claims. In any case, it is well to determine the cause of the scale by analysis of the water and to treat it externally if practically possible. Treatment and analysis of the water should be checked by a competent chemist.

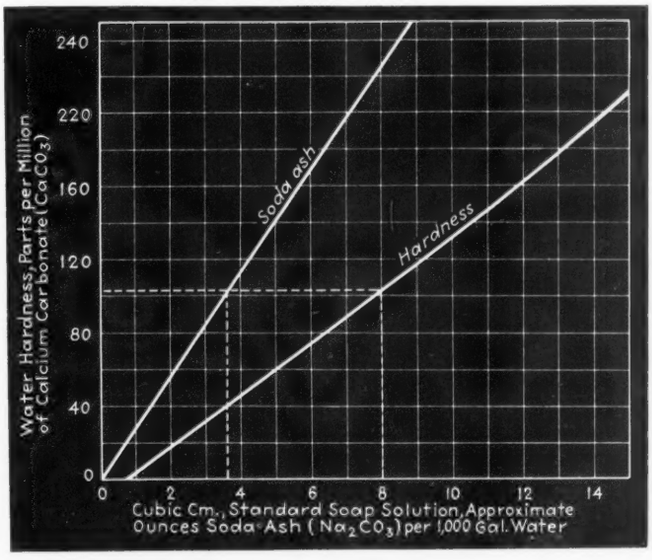
Soda ash is of some value in changing sulphates into an insoluble carbonate sludge that may be removed by blowing down the boiler. The advisability of using soda ash in a boiler operating at over 150-lb. pressure is questionable. The soda ash may break down and, with some waters, cause embrittlement. For precipitation of sulphate at higher pressures, it is best to use trisodium phosphate.

It might be of value to some plant engineers to describe a simple method for determining the amount of soda ash necessary. First, the relative hardness of the water, in terms of calcium carbonate ($CaCO_3$) is determined by use of a standard soap solution, and the hardness curve.

Soap solution is added, one c.c. at a time, to 50 c.c. of the water in a clear bottle. The bottle is shaken after each addition, until the lather covers the surface for five minutes, with the bottle on its side. Amount of soap solution used in c.c. is used for the abscissa of the curve. The equivalent hardness in parts per million $CaCO_3$ may be found on the ordinates.

Turning to the soda ash curve, the hardness point is located from the ordinates. Dropping down to the soda ash scale in the abscissa, the approximate number of ounces of soda ash necessary to soften 1,000 gal. of water may be found. Thus, a water taking 8 c.c. soap solution to produce proper lather is shown by the hardness curve as having a $CaCO_3$ hardness of 102.5 p.p.m. Following over to the soda ash curve and checking on the abscissa, it will be seen that 3.6 ounces of soda ash is required for each 1,000 gal. of water evaporated. It should be emphasized that this amount is only for the water in condition as tested. The treatment should vary according to changes in condition of the water and to load changes.

Curves for determining hardness and weight of soda ash required to soften the water



MORE BRAINS and LESS BRAWN

Trends of development and direction of progress in equipment, power-station design and operation for small and moderate size municipal steam and diesel-engine plants as presented recently in a paper before the Missouri Assn. of Municipal Utilities.

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MANUFACTURERS, engineers and operators have given extensive study to power-equipment and plant design during the depression years, to use more effectively their curtailed appropriations. Their thinking has established definite trends in small and moderate size municipal plants, many of which are now more evident than heretofore.

Steam and diesel plants constitute a majority of these installations. Usually they are separate, but of recent years more attention has been given to plants combining both types of equipment, where the combination will increase over-all economy. The advantages accruing to one particular plant by no means indicate that all other plants will be benefitted. Each project must be studied on its own merits.

Steam plants were the first to come into general use with engines as prime movers, followed by steam turbines. Transition from engines to turbines occupied some 15 to 20 yrs., during which time turbine design made rapid strides. This development was paced by higher steam pressures and superheat.

Thirty years ago the usual steam pressure ranged from 125 to 200 lb., and temperatures from about 400 to 600 deg. F. By 1920 pressures had been elevated to 150 and 300 lb. and temperatures to 500 and 700 deg. F. Since 1925 pressures have risen to 400 and 450 lb.

Over-all economic studies show that pressures of 400 lb. and temperatures of 700 deg. F. will remain the most desirable for municipal plants until increased demands on manufacturers and more knowledge, reduce the cost of higher-pressure and -temperature equipment. For the present at least, and this should include the next 5 to 10 yr. (if a prediction is permitted), engineers and operators should consider steam at this pressure and temperature as being the most desirable and give their attention to improving the heat-cycle and plant equipment. These steam conditions are applicable to even the smaller stations, a fact often overlooked by many engineers and operators.

Steam Plants

Present trends to reduce total power-production costs are generally away from radical improvements in prime movers and is directed to other parts of the plant. Between the turbine and boiler is the heat balance equipment. Usually simple in design, installation, and operation, it is nevertheless of major importance in successful plant operation. Too often it is considered a necessary evil, an attitude held unjustifiable by those who have given the matter detailed attention.

Latent heat of evaporation cannot be utilized by the turbine and is absorbed and carried away by the condenser. Feedwater heaters that use low- and intermediate-pressure steam bled from the turbine to heat the feedwater will save some of this loss. There is a distinct tendency to heat feedwater to temperatures above 300 deg. F. after it has left the boiler feed pumps. This involves more expensive high-pressure heaters and control but increases the plant efficiency.

Deaeration of feedwater is mandatory in high-pressure plants and should be in all plants. Modern trend is to use bleed steam for heating and to arrange the deaerator to operate at pressure from 15 or 20 lb. down to a vacuum without attention from the operators. A closed heater is usually placed ahead of the deaerator to utilize the lower bleed pressures and to relieve the deaerator of a wide range of operating pressures. It also relieves the duty and increases the economy at high turbine loads by automatically transferring more of the heating duty to the low-pressure bleed steam. This phase of plant development will be along lines of minor improvements of design and selection.

Surface condensers have become standard the jet and barometric types being abandoned due to excessive pumping costs and requiring 100% boiler makeup. With the surface-type, pure condensate is retained in the system and makeup runs from 3 to 10%.

Boiler equipment continues to undergo considerable improvement. Welded drums are now recognized by the A.S.M.E. Boiler Code and most state codes. The day of the riveted drum appears to be gone. Box-header boilers with staybolted surbaces are not very desirable for modern pressures although some are still used. There is no definite trend regarding straight-tube versus bent-tube boilers, although the latter enjoy a reputation for lower investment cost.

Many plants now use pulverized-fuel firing, the last few years having been a period where this equipment for small plants has been developed to a remarkable degree. Within the last year or two the "spreader" type stoker has been favorably received. Many installations of this type are under construction or consideration. Other types of stokers have also been improved.

The last year or two has seen the advent of commercial installations of the integral-furnace boiler. This is a compact unit containing boiler, superheater, economizer and water walls and is arranged for pulverized-fuel, oil, or gas firing.

Fan speeds are being controlled by means of hydraulic couplings, thus obtaining virtually an infinite number of speeds without bulky and expensive motor equipment. Combustion control is tending towards automatic or semi-automatic equipment with the operator becoming a supervisor, using his head rather than his back.

The electrical end of plants is now being given attention to provide adequate equipment for present and future conditions and safety of operators. The switchboard has ceased to be a unit crowded into a corner or along one wall, and the switchgear back of it is opened up so an operator can at last have a chance to return to his family if he has to go back to pull a disconnecting switch.

In many plants steam-driven auxiliaries are omitted and small gasoline-engine generators furnish emergency auxiliary power.

Piping has undergone radical changes in the last few years and the end is still unrealized. The most outstanding change has come with the virtual universal adoption of welding for all line joints. Welders and technic are now thoroughly qualified and readily available.

Many piping systems have been laid out by rule of thumb insofar as expansion was concerned. Much work has been done on this subject and today all properly designed systems are based on detailed study of piping strength. Analysis of old systems frequently shows that combined expansion and bursting strains have often placed plants in jeopardy. Frequently, failure of a supposed anchor has saved the property and perhaps several lives.

Summarizing the trend of steam-plant developments, perhaps two examples will serve to emphasize what is being accomplished.

In 1931, the Kansas City, Kan. plant used 2.63 lb. of coal per kw.-hr. generated, or 30,805 b.t.u. with a steam condition of

about 165 lb., and 100 deg. F. superheat. In 1935 the new 400-lb., 700-deg. plant combined with the old plant produced a kw.-hr. on 1.73 lb. of coal or 20,330 B.t.u. The fuel saving is roughly 33%

The City of Columbia, Mo., has just authorized an improvement program involving the installation of a 5,000-kw. turbo-generator, boiler and auxiliary equipment. Operation of this unit will reduce the average coal consumption from 3.11 lb. to 1.70 lb. per kw-hr. After allowing for a conservative 90% availability of the new equipment and maintaining banked fires, the fuel bill will be reduced by about 40%.

Similar savings can be made in many plants and these will often amortize the investment in a comparatively few years. Thus, needed added capacity will usually quickly pay for itself out of operating savings.

Diesel Equipment

Diesel engines and generators form the only major items of equipment in the diesel plant. Plants installed and improved in the last few years demonstrate that more attention is being given to the auxiliary equipment by engineers and operators.

Manufacturers have successfully increased engine operating speeds. Railway-type diesels up to 3,600 hp. at 600 r.p.m. and their success will undoubtedly influence the design of stationary engines. Today's top speed is about 400 r.p.m. and the lowest is about 225 r.p.m. for small- and medium-size units.

Fuel-injection systems are receiving detailed attention by all manufacturers. The solid-injection system continues to be the most popular and much effort is being given to improve its operation with the lower-grade, heavier fuels. Legislators with the tax complex will play an increasingly important part in fuel systems. Higher taxes on fuel oils will cause operators to purchase the heavier and least expensive oils and engines with ability to burn them will be the most popular. High-speed engines require light fuels and the increasing use by truck, bus, mobile machinery, and railway engines will create a demand for these oils that will probably raise oil prices and force the stationary engines to heavy oils. This trend is once more directing attention to air-injection systems.

The type of cycle for tomorrow's engine is a moot question, but many believe that it will be the two stroke. In such engines there has been considerable improvement due to the mobile-machinery engine where space and weight have been controlling factors. This knowledge is being applied to larger engine designs. Scavenging will be improved and with it will come increased efficiencies.

Diesel and Steam

Considerable attention has been given to combining diesel and steam plants. The diesel may be used as a peak-load or a base-load unit, the former being the most popular for several reasons.

Visualize a moderate-sized plant that has the usual number of small steam units and a load that warrants an increase in plant capacity. In this plant may be one or two fairly modern turbines that use sufficiently high steam pressure to insure satisfactory efficiency. They form the backbone of the plant, supplemented by older, less efficient units, such as low-pressure steam engines.

To install a turbine, boiler and auxiliaries of sufficient size for single-unit operation, will place a heavy financial burden on the plant. Also using this unit on light loads will not greatly benefit operating efficiency. Providing other conditions warrant, the problem may be economically solved by installing a diesel engine of sufficient size to act as a peak unit for a considerable number of years.

The plant would then operate as a base-load steam plant, the turbine taking approximately full load, and operated at a fairly high capacity factor with consequent high economy. Whenever the load reaches a predetermined value the operator starts the diesel and has it carrying load in less than two min. Should the load drop, as during noon hours, the diesel is stopped and there it remains without standby or banking losses until it is required.

Several incidental savings are possible, as for instance the exhaust gases may be passed through a heat exchanger and used to heat the boiler feedwater. When the diesel is operating at 75% load or higher, it is possible to recover in this manner about 10 to 15% of the heat in the fuel oil. Circulating water and boiler-feed pumping costs are reduced over similar full steam-plant operation. This combination may permit placing the jacket-water coolers in the condenser discharge lines, thereby obviating pumping water in the outer circuit of the diesel-cooling system. Another advantage is that the diesel unit permits quickly placing the steam plant back on the line in a forced shut down.

Each project must be separately analyzed, but it is surprising how many plants are amenable to this type of improvement. Variations of the foregoing procedure are many. Where natural gas is available at an attractive price, natural-gas engines can be substituted for diesel engines.

Some plants have been improved on the basis of making the diesel or gas engine the base-load unit and using existing steam units as stand-by or peak-load units. The Chicago Stock Yards power plant uses its diesel for a base-load machine while the City of Greenville, Texas, installed two diesels for regular service with an old steam-turbine plant held in reserve. In the latter, the coal-fired boilers were converted for oil firing and the boiler water is maintained quite hot by passing it through a waste-heat boiler in the engine-exhaust passages.

Properly applied, the combined plant can show a satisfactory return on the investment and more of these plants will be installed. Since each plant must be separately studied and results vary quite widely due to their dependence on local conditions, exact savings will not be given here, as they might be misleading.

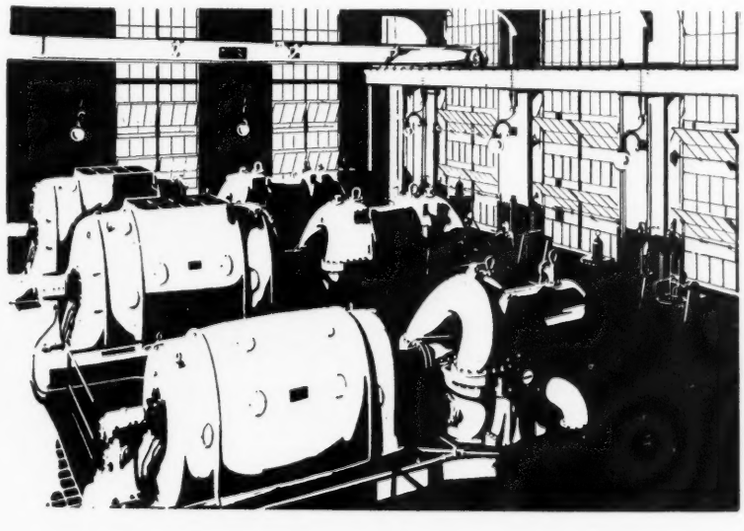
Summarizing the trend in design, it is seen that not only have manufacturers continued to improve equipment and to enable plant owners to obtain it at a cost that will show a satisfactory net earning, but purchasers have begun to give detailed attention to the proper design of their plant. This condition is bound to produce results that will enable plants to stand on their own financial legs and to meet the demand for lowered rates.

Trend in Operations

Three essentials constitute the basis for a successful power plant. These may be briefly described as, properly designed and adequately built equipment; properly coordinated and carefully selected equipment that is correctly installed; and intelligent operation. Proper operation is sometimes lacking in municipal power plants, but this condition is being overcome with a definite trend toward the use of more brains and less brawn in their operation.

It is unfortunate that managers, superintendents and commissions have often failed to realize that their plants have outgrown their swaddling clothes and are now healthy businesses that require closer supervision and more careful operation if they are to meet today's and tomorrow's requirements. Yesterday's ruts must be abandoned for today's highways or the plant will be unable to maintain its financial independence and at the same time retail energy at satisfactory rates. Should proper operations be deferred the operating personnel will eventually hear from the consumer-owners in no uncertain terms.

Manufacturers, engineers, and operators have all been forced to develop and improve their products and methods during the depression years and this has resulted in numerous advances that are now being felt throughout the industry. With a return to more prosperous times it is natural to expect dividends from these advances. These dividends should and will be demanded by the consumers and should also be desired by all others interested in the welfare of power plants.



SPEAKING OF POWER

• A LOT of us are looking forward to the World Power Conference in September with keen interest. But it's more a matter of personalities than of papers. The Washington sessions (Sept. 7-12) will consider fuels and power from the high vantage point of the national economic and social life. Presumably they will broaden our outlook and make us better citizens, but they won't tell us how to get better efficiency out of a turbine or decrease the cost of steam. . . . However, it would be narrow-minded to complain about that, because such problems certainly deserve study, and the W.P.C. sessions are the logical time and place. Moreover, the Conference will be preceded and followed by intensely practical study tours to centers of power and fuel interest, so the delegates can see American power plants and talk shop with the men who built and run them.

broaden outlook

I started to talk about the personalities. To me the greatest thing about this Conference, the first held in America, will be the chance to meet hundreds of first-class engineers from England, Germany, France, Sweden, South America and other foreign countries . . . I think that they, in turn, will get as much out of seeing America and meeting American engineers as they will out of the purely technical aspects of the Conference. Both those who come over and those who greet them here will "See the world."

I passed a theater the other day with the sign "40 degrees cooler inside" on the entrance. Outside temperature was 75 at the moment, so I moved on. Some of these places used to claim a 20-degree drop when they had nothing but fans. Shows where you land when you start painting the lily. . . . Eventually the public will learn that even an air-conditioned building is more comfortable (and far safer) when its temperature is well over 70 on a sizzling day. . . . By the way, the heat wave in July was certainly an effective advertisement for air conditioning. . . . Did you notice how the money flowed into the air-conditioned theaters and restaurants when the mercury hit the ceiling?

Money flowed in

For the past few months, you may have noted, I've had in mind the thought that the steam engine may have a lot more possibilities than some folks imagine. I'm thinking not so much of what can be done with today's standard types, as where we could go with a combination of high speed, pressure and light weight . . . High speed is largely a matter of well-balanced design, as in existing high-speed internal-combustion engines, multi-cylinder vertical or opposed-piston. Another essential is some arrangement of valves and ports that will get the steam in and out of the cylinder with the least amount of fuss and wiredrawing. And, of course, the uniflow principle should be incorporated for the sake of efficiency. Higher speed should mean cheaper engines, probably with little sacrifice of efficiency. It will certainly mean cheaper generators and less floor space. . . . I have no idea, of course, that the steam engine will ever return as a prime mover for large power stations, but it should certainly have a future for small high-pressure industrial and building jobs, unless some way is found to make the small high-pressure turbine more efficient. . . . One of my trusted engineering friends tells me that this whole idea is a pipe dream. Maybe he is right, but I'd certainly like to see a little debate on the subject in the discussion pages of *Power,* particularly by those who are familiar with the advanced and experimental high-speed designs.

pipe dream

To get a bit away from commercial power-house design I remember a model engine I saw a while ago. Weighed 2 lb., generated 2 hp., and ran at 9,000 r.p.m. Steam pressure, 500 lb.; bore, 0.656 in.; stroke, 0.625 in. Two opposed cylinders, single-acting. Shows what a combination of high speed and high pressure can do.

The staff is working hard on the Firing Section which will occupy 24 pages in September *Power.* In concise fashion, it will give the practical facts on stokers, pulverizers, and burners for pulverized coal, oil and gas. We believe power engineers will find it helpful on their daily jobs.

Some explain America's high-standard of living on the basis of natural resources. Some credit it to the capitalistic system, some to high or low tariff, some to the Democrats and some to the Republicans. Some think it is because Americans have a lot of initiative and some say it is because they have a lot of brains. Others think that the large consuming power of a large population explains the situation. Finally, some experts point out that the United States uses more horsepower per worker than any other country. To me it seems reasonable that the nearly five invisible horses driven by every American factory worker have as much to do with his productivity as several of the other things mentioned. Everybody knows that productivity means prosperity, because what people make and raise they wear, eat and live in. Plenty of all that *is* prosperity.

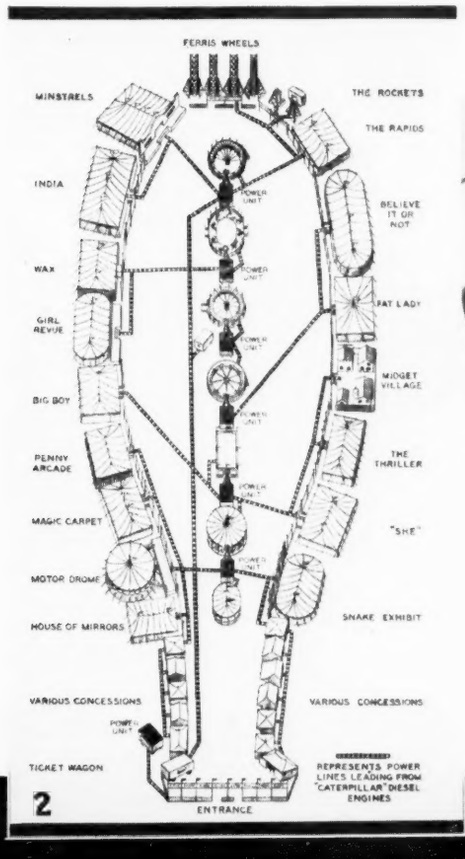
invisible horses

PHIL SWAIN
Editor

PORTABLE POWER

Royal American Shows, "World's Largest Midway" (5), needs light for concessions and "pulling" crowds, power for amusement devices and for the electric snake-pen heaters. Peak loads hit 400 kw., power bills ran $40,000 a season, and the Show had to "go in" where power was available. So Vince T. Book, master mechanic, built seven special 8x8½x 14-ft. wagons (4) with drop sides to form stages (3) each containing a 60-kw. diesel set and acting as a base for a collapsible steel-and-aluminum 67-ft. tower carrying a ton of floodlights (1). Lights and tower go within the wagon for traveling. The 6-cyl., 125-hp., Caterpillar diesels driving GE alternators use about 4½ gal. per hr. of 6-cent fuel, and lubricating oil is changed after 70 operating hr. Fuel expense is expected to be $5,000 this season, and the sets are expected to pay out in two seasons, working 6 hr. a day, 6 days a week, for 6 months.

1



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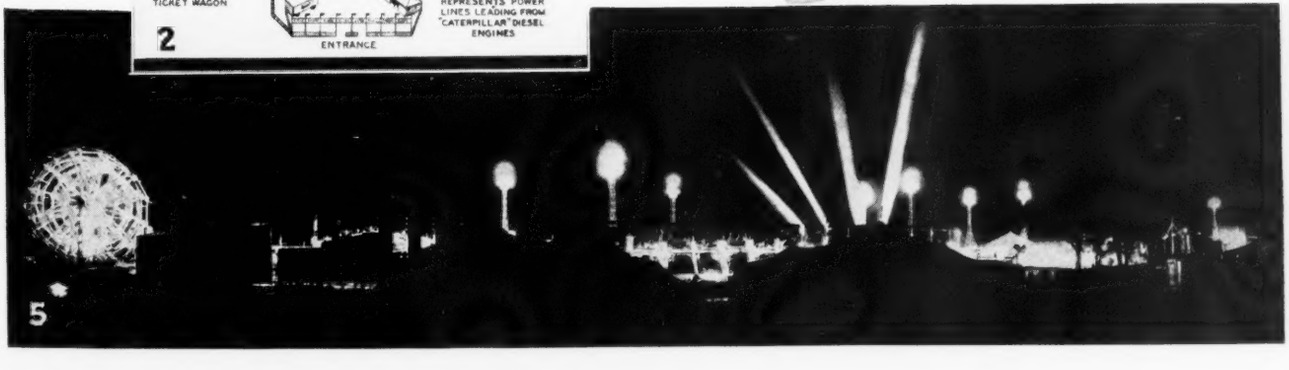

5

RILEY cuts steam

LYNN GAS & ELECTRIC CO., Lynn, Mass.
205,000 lbs. of Steam per hour
430 lbs. Press. - 810°F Steam - 86.1% Eff.
Stone & Webster Engr. Corp., Engrs.

TITANIUM PIGMENT CORP., Sayreville, N. Y.
125,000 lbs. of Steam per hour
448 lbs. Press. - 637°F Steam - 85% Eff.
Ford, Beacon & Davis, Engineers

at left

W. VA. PULP & PAPER CO., Covington, Va.
375,000 lbs. of Steam per hour
600 lbs. Press. - 750°F Steam - 85.7% Eff.
W. Va. Pulp & Paper has purchased Riley Units for their Luke, Md., Williamsburg, Pa., and Charleston, S. C., plants also

That is why Industry has

costs for Industry

Through installation of modern efficient Riley Steam Generating Units industry has been able to make tremendous reductions in the cost of steam and power production.

Because of the low cost of producing steam when using Riley Steam Generating and Fuel Burning Equipment and the unusually satisfactory and reliable operation of this equipment, industry has very definitely swung to Riley.

This preference for Riley equipment has been of such magnitude that Riley sales have increased steadily since 1931 and to such an extent that sales in 1935 were greater than in 1929. Sales to date in 1936 have been practically double those of the corresponding period of 1935.

Be sure to investigate Riley equipment when considering modernization of your boiler plant.

RILEY

STOKER CORPORATION

WORCESTER - MASSACHUSETTS

COMPLETE STEAM GENERATING UNITS

BOILERS - SUPERHEATERS - AIR HEATERS - ECONOMIZERS - PULVERIZERS - BURNERS - STOKERS

WATER-COOLED FURNACES - STEEL CLAD SETTINGS

Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Tacoma
St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta

LARGE CHEMICAL COMPANY

80,000 lbs. of Steam per hour
600 lbs. Press.-650°F Steam-83.5% Eff.

This also recently purchased 2-100,000 Riley Units

LARGE EASTERN OIL REFINERY

300,000 lbs. of Steam per hour
650 lbs. Press. - 740°F Steam - 83% Eff.

CELANESE CORP. of AMERICA
Cumberland, Md.

150,000 lbs. of Steam per hour
440 lbs. Press. - 710°F Steam - 85.5% Eff.

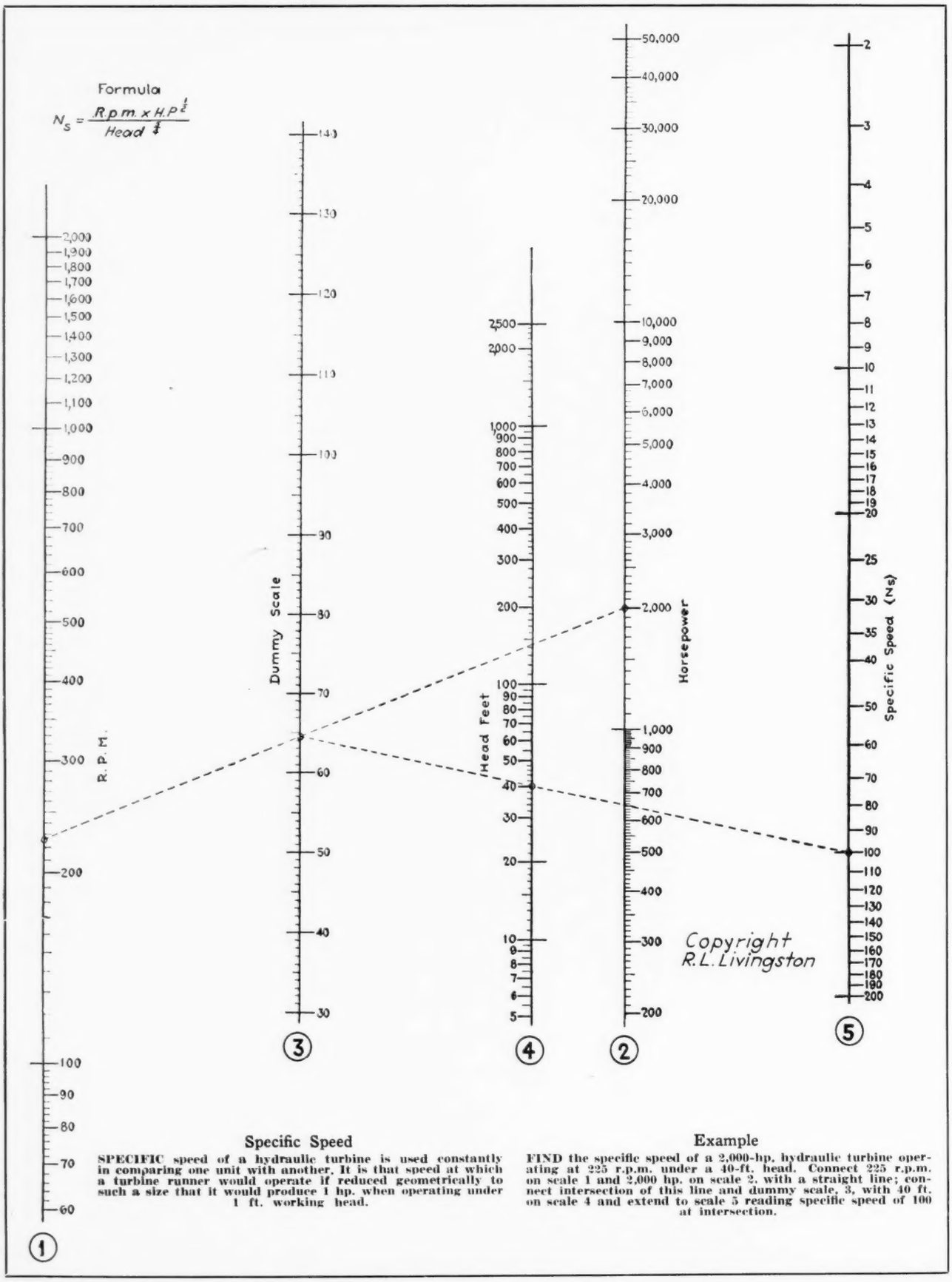
The SWUNG to Riley Continues . . . A Few of the Recent Installations of Riley Units . . .

Fort Bend Utilities, Sugarland, Texas
West Virginia Pulp & Paper Co., Charleston, S. C.
University of Minnesota, Minneapolis, Minn.
Bemis Brothers Bag Co., Peoria, Ill.
Imperial Color & Paper Co., Glens Falls, N. Y.
Socony Vacuum Oil Co., Naples, Italy
Upper Michigan Power & Light Co. Escanaba, Mich.
West Virginia Pulp & Paper Co., Williamsburg, Pa.
Carbide & Carbon Chemical Co. Charleston, W. Va.
Holyoke Water Power Co., Holyoke, Mass.
Standard Oil Co. of California, Richmond, Calif.
Whippany Paper Board Co., Whippany, N. J.
Owens Illinois Glass Co., Newark, Ohio
American Laundry Machine Co., Rochester, N. Y.
Crystal Tissue Paper Co., Middletown, Ohio
Arnold Print Works, N. Adams, Mass.
Savannah Sugar Co., Savannah, Ga.
Beechnut Packing Co., Canajoharie, N. Y.
Crompton & Knowles Loom Works Worcester, Mass.
Container Corp. of America, Philadelphia, Pa.
Kalamazoo Vegetable Parchment Co. Kalamazoo, Mich.
Ames Worsted Co., Southbridge, Mass.

SWUNG to Riley Equipment

Number 47

Specific Speed of Hydraulic Turbines



Specific Speed

SPECIFIC speed of a hydraulic turbine is used constantly in comparing one unit with another. It is that speed at which a turbine runner would operate if reduced geometrically to such a size that it would produce 1 hp. when operating under 1 ft. working head.

Example

FIND the specific speed of a 2,000-hp. hydraulic turbine operating at 225 r.p.m. under a 40-ft. head. Connect 225 r.p.m. on scale 1 and 2,000 hp. on scale 2, with a straight line; connect intersection of this line and dummy scale, 3, with 40 ft. on scale 4 and extend to scale 5 reading specific speed of 100 at intersection.

© POWER

HIGH-PRESSURE POWER PLANTS FOR DISTRICT HEATING

Henry Kreisinger, Research Engineer, Combustion Engineering Co., sees a field for high-pressure power plants exhausting to district-heating systems. Abstract of a paper presented before National District Heating Assn. at Grand Rapids, Mich., June 18

THE SUPERIMPOSED high-pressure, high-temperature steam cycle has economic application in the field of district heating. This is especially true where there is a substantial demand for steam during the entire year, the baseload steam being passed through high-pressure turbines before passing to the steam distribution system.

Fig. 1 shows heat distribution of fuel burned in power-generating plants operating at five different sets of conditions. The condenser losses represent the greatest opportunity for heat saving by high-pressure operation. Boiler-room losses are taken as a constant percentage of the heat in the fuel burned, giving a higher absolute value for the lower boiler pressures.

The total height of each column is proportional to the coal burned per kilowatt-hour of output and, therefore, is also proportional to the size of the equipment used to handle, prepare and fire the coal, and the size of steam-generating unit. Condenser-loss rectangle is proportional to the condenser size and its auxiliaries. The first column represents the most recent designs of high-pressure power-generating plants generating a net kilowatt-hour on 11,800 B.t.u.[1] with four stages of bleeder heating.

The second column represents a steam cycle with 1,200 lb. and 740-deg. at the throttle. Steam is reheated with high-pressure steam between the high- and low-pressure turbine at about 80 lb. This cycle also includes four stages of turbine bleeding for feedwater heating. The heat rate per net kilowatt-hour is about 12,300 B.t.u. Reheating with high-pressure steam has as its main objective the reduction of moisture content in the expanded steam, rather than an increase in the thermal efficiency of the cycle.

The third and fourth columns represent cycles with steam at 400 lb. and 740 deg. at the turbine throttle, using three and no stages, respectively, of bleeder heating. In the last column the steam temperature of 740 deg. is somewhat higher than is necessary for 225 lb., but is used to make this cycle comparable with those of the third and fourth columns.

This diagram shows to what extent the high-pressure and high-temperature steam cycle reduces the size of steam generating and condensing equipment, thus partly balancing the increased cost of heavier high-pressure construction. The condenser losses are to some extent a measure of the amount of steam that may be made available for heating purposes in a case where high-pressure steam power generating cycle is superimposed on a heating system. They also indicate that, with a given base heating load, more power can be generated by using the highest practicable steam pressure superimposed on the heating system.

The business of generating power and the business of generating steam and distribution for heating and similar uses are closely associated, and in many cases are becoming merely departments of one consolidated business. By careful planning of the design and location of the central station, a substantial part of the power can be generated as a byproduct with nearly 100% thermal efficiency.

Because very little or no superheat is required for steam heating, the initial temperatures of the high-pressure steam of the superimposed power generating cycle need be only moderately high, thus avoiding the difficulties associated with high-temperature design.

Fig. 2 shows how much power can be generated per 1,000 lb. of steam with a given initial pressure and temperature, and exhausted from the high-pressure turbine into a heating system at either 214-lb. or 114-lb. absolute pressure. The scale at the right indicates the initial temperature required to give about 5 deg. superheat, exhausted into the heating system. From the lowest curve it will be seen that for an initial pressure of 1,200 lb. about 36.5 kw. can be generated for each 1,000 lb. of steam per hr.; Curve 3 shows that a throttle temperature of 730 deg. is required. Corresponding figures for 1,200-lb. throttle steam and 114-lb. heating steam are 51 kw. and 785 deg. throttle temperature. The curves were prepared for 80% efficiency of steam expansion in the turbine, and generator

[1] The Port Washington Station, operating on this cycle, has recently shown an exceptional performance of 10,946 B.t.u. per net kw.-hr. for an entire month.

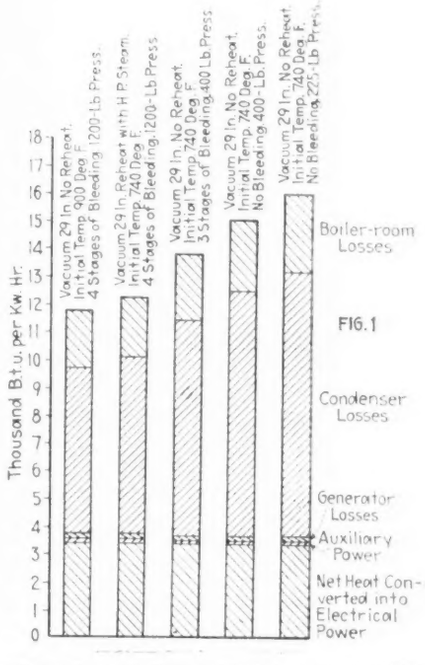

Thousand B.t.u. per Kw Hr.
Vacuum 29 In. No Reheat. Initial Temp 900 Deg. F. 4 Stages of Bleeding 1200-Lb Press.
Vacuum 29 In. Reheat with H P Steam. Initial Temp. 740 Deg. F. 4 Stages of Bleeding 1200-Lb Press.
Vacuum 29 In. No Reheat. Initial Temp 740 Deg. F. 3 Stages of Bleeding 400 Lb Press
Vacuum 29 In. No Reheat. Initial Temp. 740 Deg. F. No Bleeding 400-Lb. Press.
Vacuum 29 In. No Reheat. Initial Temp. 740 Deg. F. No Bleeding 225-Lb Press.
Boiler-room Losses
Condenser Losses
Generator Losses
Auxiliary Power
Net Heat Converted into Electrical Power

FIG. 1

Fig. 1—Heat distribution of five power-generating cycles. Fig. 2—Power that can be generated by superimposing high-pressure cycle on a heating system. Fig. 3—Power that can be generated by superimposing a high-pressure cycle on an old power plant operating at 214-lb. abs. and either 560 or 600 deg. F.

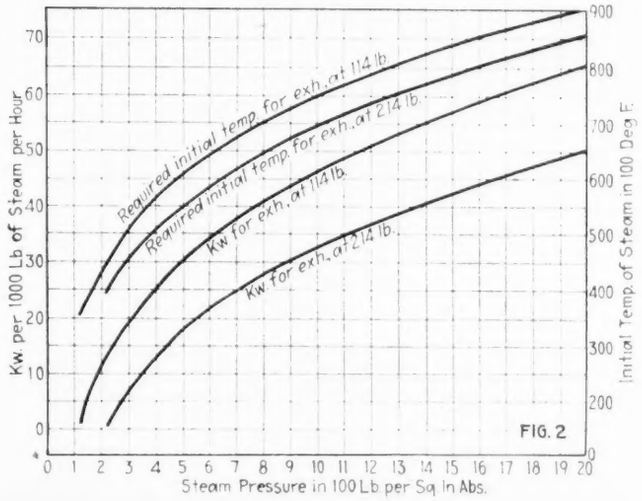

Kw per 1000 Lb of Steam per Hour
Initial Temp. of Steam in 100 Deg. F.
Required initial temp. for exh. at 114 lb.
Required initial temp. for exh. at 214 lb.
Kw. for exh. at 114 lb.
Kw. for exh. at 214 lb.
Steam Pressure in 100 Lb per Sq. In Abs.

FIG. 2

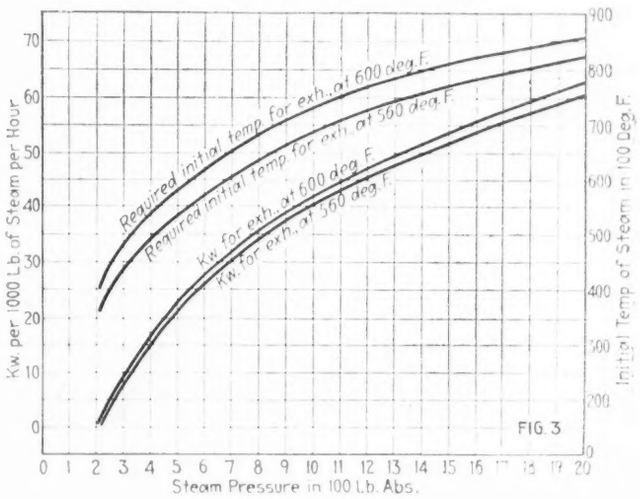

Kw. per 1000 Lb. of Steam per Hour
Initial Temp of Steam in 100 Deg. F.
Required initial temp. for exh. at 600 deg. F.
Required initial temp. for exh. at 560 deg. F.
Kw. for exh. at 600 deg. F.
Kw. for exh. at 560 deg. F.
Steam Pressure in 100 Lb. Abs.

FIG. 3

losses of 5% of the energy represented by the 80% steam expansion.

Superposition of the high-pressure cycle on a heating system is particularly well adapted to many industrial plants and industrial districts where large amounts of steam and power are required at all seasons. In such cases the initial pressure can be chosen to balance the demands for power and for heating steam.

Industrial plants have been quick to see the advantages of superimposing power generation on their steam heating systems. Many of them have already installed high-pressure equipment to supply their power and heating steam, and many more are planning to do so in the near future.

In connection with district heating, the possibility of increasing the use of steam in summer and of power in winter should be studied. Such studies should be directed particularly to new uses of steam and power that would make the base load as large as economically practicable. Some advantage might be gained by varying the exhaust pressure. In winter when the heating load is heavy the exhaust pressure might be 200 lb., in summer the pressure could be dropped to 150 or 100 lb. Lower exhaust pressure in summer would make it possible to generate more power with the steam demanded for heating, and thereby reduce the amount of steam condensed in the power generating station. A lower exhaust pressure would be sufficient to move the smaller weight of summer steam through the heating system. There might also be a small gain in power by raising the initial pressure. It is true that such pressure changes would change the condition of the exhaust steam from small superheat to moisture; but this might not be a serious objection.

When the high-pressure cycle for the generation of power is superimposed on a heating system, boiler feedwater becomes a problem. Usually little or no condensate is returned from the heating system and the boiler feedwater consists largely of treated makeup water. Evaporators can be used to generate low-pressure steam with the exhaust of the high-pressure turbine, but these add to the cost of the plant. Moreover, the water going to the evaporators must be treated if they are to remain in service for reasonably long periods. There is now a tendency to eliminate evaporators and to feed the boiler with treated makeup.

Many plants in successful operation at moderately high pressures use treated makeup water exclusively for feeding the boilers, carrying a total concentration in the boiler water between 2,000 and 3,000 p.p.m. It is probable that most of the waters available for feeding boilers can be treated successfully so that there would be no pressure limit to satisfactory operation with treated makeup water. The solution of this problem should be entrusted to the boiler-water treatment specialists. When the use of treated makeup water is considered in a new installation the water treatment problem can be more easily solved if the designer of the boiler cooperates with the feedwater specialist. The boiler designer can then embody in the boiler design the features that are necessary for obtaining clean steam.

Such provisions may include large steam drums containing sufficient space for the separation of steam from water and for the installation of steam cleaning devices. Another feature in the design of the boiler is the careful location of the feedwater inlet into the drum and the location of the blowdown. The blowdown should be taken at the point of highest concentration in the boiler water in the drum. The feedwater should enter the boiler in such a way that it will not dilute the water at the blowdown, but at the same time the feedwater should mix thoroughly with the water in the drum before it flows into the tubes of the boiler. In high-pressure boilers with water-cooled furnaces a large part of the evaporation takes place in the furnace walls and only a small amount of additional boiler surface is required.

Fig. 3 shows a relation similar to Fig. 2, applied to cases where the high-pressure and high-temperature cycle is superimposed on a low-pressure power generating plant using steam at 200 lb. gage, and either 560 or 600 deg. F. Thus, with initial steam pressure of 1,200 lb. and 560-deg. steam temperature to the low-pressure turbine, about 46 kw. can be obtained per 1,000 lb. of steam per hour, and the initial temperature is 930 deg. F. The curves are calculated on the same assumptions as those of Fig. 2.

THE ENGINEER'S BOOKSHELF

Photo-Elasticity

MANUAL OF PHOTO-ELASTICITY FOR ENGINEERS (1936)—*By L. N. G. Filon. Published in Cambridge, Mass., by University Press, and in New York by The MacMillan Co., 60 Fifth Ave. 140 pages, 5 x 7½ in. Cloth. 27 diagrams. Price $1.50.*

Admittedly, the purpose of this little book is merely to give to a practical investigator, who wishes to use photo-elastic devices to find the stress-distribution occuring in any problem, a simple text which will enable him to set up his apparatus and use it to best advantage. Six chapters are: Polarized Light, Uniform Stress, Optical Exploration of Non-uniform Stress, The Model, The Polariscope and the Optical System, The Independent Measurement of P+Q.

Diesel Maintenance

MAINTENANCE OF HIGH-SPEED DIESEL ENGINES (1936)—*By Arthur W. Judge. Published by D. Van Nostrand Co., Inc., 250 Fourth Ave., New York, N. Y. 192 pages, 5½ x 8½ in. 170 illustrations. Price, $5.*

Though planned primarily for high-speed engines, some of the data included in this book are good tips for other types. The author assumes the reader to be generally familiar with gasoline-engine maintenance, so gets right down to cases on the special problems of the diesel. Included are data on engine adjustments, analysis of troubles and remedies, fuel pumps and injectors, starting and slow running, much of it based on experiences of English diesel builders.

The book is divided into twelve chapters: Working principles; practice; general maintenance; cylinders; pistons and rings; valves and seats; connecting rod and crankshaft; fuel-injection system; timing the fuel pump, the governor; starting procedure and running troubles; glow plugs, filters, fuels, etc.; C.A.V. Bosch fuel-injection equipment.

Feedwater Treatment

BOILER FEEDWATER TREATMENT (1936)—*By F. J. Mathews. Exclusive American distributors—Chemical Publishing Co., of New York, Inc., 148 Lafayette St., New York, N. Y. 526 pages, 5½ x 8½ in. Cloth. 27 illustrations. Price, $5.*

Because there is still a dearth of good modern books on feedwater treatment, this edition will be welcome, particularly so because it includes accounts of a new method of treating boiler feedwater developed during the past ten years.

In addition to the usual discussion of natural waters, lime—soda and zeolite softening, Mr. Mathews discusses water blending, lime-varium softening, the use of sodium aluminate, the action of colloids, the meaning and purpose of carbonates and phosphates.

The latter half of the book deals with corrosion, foaming and priming, analysis and routine testing. An appendix includes directions for preparing standard solutions required in analysis, Clark's table of hardening, and chemical factors.

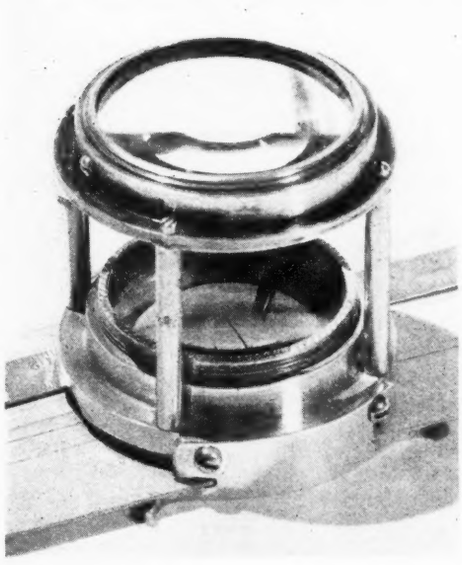
Brief Reviews

DIESEL, THE MODERN POWER (1936). *Published by Technical Data Dept., Research Laboratories Section, General Motors Corp., Detroit, Mich. 32 pages, 5¼ x 8¼ in. Paper. Profusely illustrated. Free*—Illustrations and text are combined to give a good elementary description of the diesel; its development, construction and application.

ELECTRIC LIGHT & POWER INDUSTRY IN 1935 (1936). *Published as Statistical Bulletin No. 3 by Edison Electric Institute, 420 Lexington Ave., New York, N. Y. 38 pages, 8 x 11 in. Paper. Mostly tabular with some charts. Price 30 cents to members, 75 cents to non-members.*

TAPER ROLLER BEARINGS (1936). *Simplified Practice Recommendation R67-36. Published by U. S. Dept. of Commerce, National Bureau of Standards. 10 pages, 6 x 9 in. Paper. 4 tables and 4 figures. Price, 5 cents from Superintendent of Documents, Washington, D. C.*

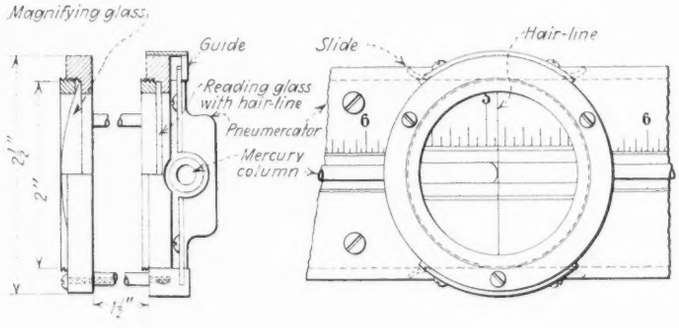
PRACTICAL AIDS TO OPERATION



Magnifies Oil-Gage Readings

EVERY engineer who has used a pneumercator gage to measure the amount of oil in a tank realizes how difficult it is to get the exact reading. Furthermore, it is also difficult to get two operators to read the gage alike when they take simultaneous readings. In our plant we have overcome this trouble by using a magnifying glass made as shown in the photo and drawing. The reading glass is made so that it fits over the edges of the gage and can be moved along it, to where the reading is to be taken.

A hair line on the reading glass is placed at right



angles to the scale readings. When taking a reading this line is placed so that it just cuts the top of the meniscus of the mercury column. The line then gives the exact place on the scale to take the reading and the enlarged divisions, as seen through the lens, greatly assists in getting it accurately. The eye does not necessarily have to be vertically over the hair line when taking the reading. The mercury column and scale are about equal distances away from the hair line. Therefore, as long as the hair line is seen at the top of the meniscus when the reading is being taken a correct indication on the scale will be obtained.

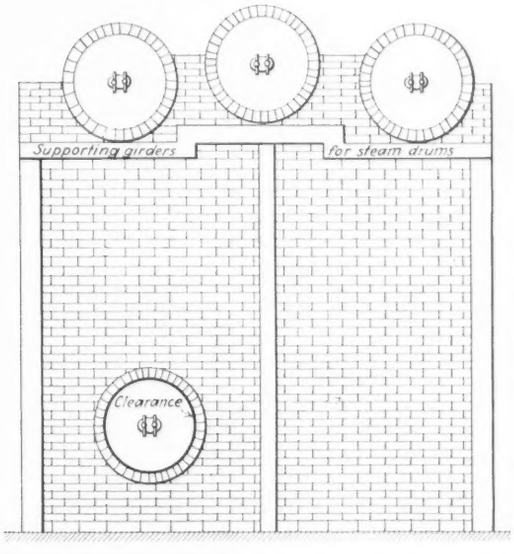
Bronx, N. Y. D. ELLIS

Changing Pump Packing Halves Power Costs

FOR packing a small plunger-type, drinking-water circulating pump a type recommended by the manufacturers was used. Because of appearance and cleanliness it was desirable to keep water leakage to a minimum around the plungers. To do this required packing the pump once a month. The cost of the 12 rings of packing was about $1.00 and during three years that the pump had been in operation we had grown to regard this cost a moderate expense.

A representative of another packing company suggested using a packing that cost 13 times as much as the old. Accepting the salesman's offer that all charges would be cancelled if the new packing did not save sufficient power to pay its cost, a trial installation was made. Before making the change we borrowed a meter and ran a test with the old-type packing for 13 days. During this time the power consumption averaged 15 kw.-hr. per day. Then the new type packing was installed and, to our surprise, daily power consumption dropped to 7.5 kw.-hr., a saving of approximately $65.00 per year and five times the cost of the packing. After 18 mo. service the packing was still in use. This experience and many others have led me to favor quality, even though many executives, from engineers up, want to deal on a basis of price.

Wichita, Kan. J. F. WOOLEY



Restricted Expansion Causes Tube Leakage

A LARGE manufacturing plant installed two 4-drum, 150-lb. bent-tube boilers and later added another similar but larger unit for 350 lb. pressure. About a year ago the side walls were rebuilt on the old boilers, and repairs were made to one wall of the new boiler. Shortly after starting up the two 150-lb. boilers, several tubes showed leakage at the lower ends.

The boilers were shut down and since leaky tubes were

found in good condition, they were re-expanded. After several more days of operation, 8 tubes in one 150-lb. boiler, and 14 tubes in the high-pressure boiler began to leak. Further examination of the tubes and tube holes showed no defect. Investigation finally disclosed that the mud drums were bound by the brick work. Regardless of the method used to support the steam drums, the mud drum should be supported by the boiler tubes and it must be free to move in any radial direction caused by expansion or contraction of the tubes. The mud drum may move downwards as much as $\frac{3}{4}$ in. when the temperature of the tubes is raised to operating value.

Movement of the mud drum is provided for by leaving about 1.5-in. clearance between the drum surfaces at each end and the masonry, as in the figure. Draft leakage at this space is sealed by plastic cement.

If the mud drum is anchored by brick work, the tubes when expanding may break their expanded seats and push through the tube holes. This condition may occur at either end of the tubes depending upon the drum thickness and other factors, causing leakage and making re-expanding of tubes necessary.

In the plant referred to, the masons neglected to leave the clearance for mud-drum movement when making the side wall repairs, and the tube leakage resulted. After cutting the brick work back to provide proper clearance, no further difficulty was experienced.

Chicago, Ill. R. O. BILLINGS

Steel Rule Locates Steam Leak

IT WAS known that a steam leak existed in the high-pressure cylinder head of a large portable steam engine using superheated steam. Because the steam was invisible where it came from the defect it could not be determined by visual inspection if the leak was through a defect in the cylinder head or in the joint. A careful examination was made of the cover and joint with a polished-steel rule. Condensation of steam on the rule showed the leak to be through the cover. When the cover was removed the casting was found to be defective. A mirror might have been used to make the test instead of the rule.

Shipley, England F. DOUGHTES

Obtaining Power Factor With Two Meters

WHEN power is bought under a rate having a power-factor clause, giving a bonus for high and penalizing low power factor, it is important to know what power factor is obtained under various conditions of operation. The metering is done by two duplicate meters, one connected to register power and the other reactive load. The average power factor over a period can be calculated by taking the square root of the sum of the squares of the two meter readings, which would give the kilovolt-ampere reading. This value divided into the power meter reading gives the power factor. Instead of making this calculation, the reactive-kva. reading is divided by the kilowatt-hour reading and the quotient looked up in a table that gives the average power factor directly.

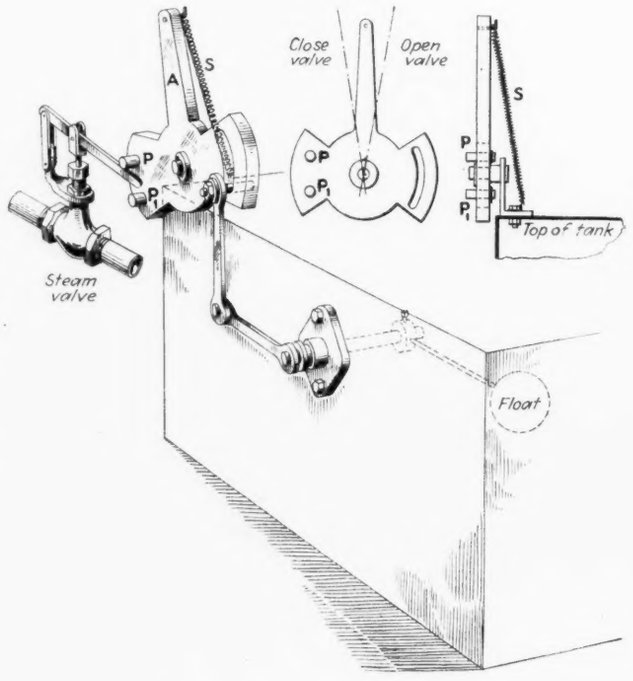
Power-factor readings obtained over a period do not tell when a high or low power factor occurred. An easy way of doing this is to count the revolutions made by the meter disks, simultaneously. The meter readings are in proportion to the number of revolutions of the disk. Then dividing the reactive-meter r.p.m. by the power-meter r.p.m., a quotient is obtained that can be looked up on the table and the power factor determined.

It may be that the power factor is only 0.80. Then, if synchronous motors form part of the power load, by increasing their field current it is possible to adjust the power factor to any desired value within certain limits. When checking over an installation it is good practice to get individual power-factor readings for various combinations of load. Then in many cases operation can be changed or adjustments made to obtain a better average power factor over the month.

Sayreville, N. J. K. B. HUMPHERY

Steam-Syphon Operation Made Automatic

A HAND operated steam-syphon valve was made automatic by a float in the sump through a quick-movement device made from a piece of flat iron and mounted on top of the sump tank as shown. Two pins P and P_1 in one of the quadrents of this device open and close the



steam valve. The other quadrent is slotted and connects to an arm on the float shaft. The vertical arm A of the quick movement device is normally thrown to the right when the sump is full and to the left when the sump is empty, by a spring S.

Assume that the sump is empty: Then, the quick-movement arm A will be thrown to the left, the steam valve will be closed and pin P will be resting on top of the valve lever to limit the throw of arm A. The pin in the float angle that connects it to the right-hand quadrent is near the center of travel in the slot. Now, as the water level rises in the sump the float will move the pin in the quadrent slot downward until it reaches the bottom. Further movement of the pin turns arm A to the right

until it passes the vertical center line, when spring S throws the lever quickly to the right. When pin P_1 strikes the valve lever it opens the valve with a quick action. The reverse operation takes place to close the valve when the sump is emptied.

Norfolk, Va. W. C. ROUGHTON

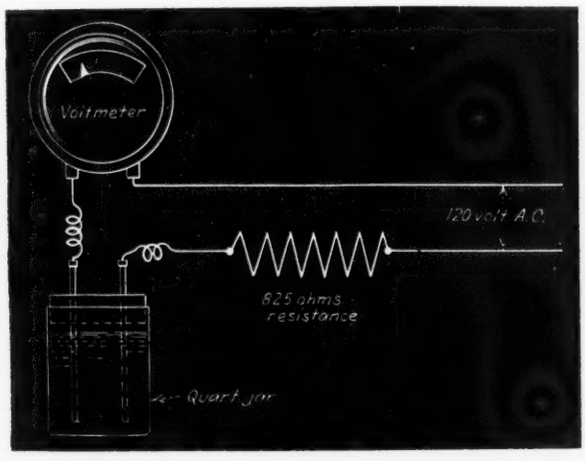
Checks Condenser Leakage With Voltmeter

IN OUR municipal-light plant it was desirable to know the condenser leakage into the hotwell, but an appropriation could not be obtained with which to purchase a conductivity meter. We then decided to make one out of old equipment that would at least give us an approximate idea of condensate conditions. The results from using this equipment have been very satisfactory.

The conductivity equipment was made from an old 200-volt voltmeter, an 825-ohm resistor, a quart jar with a rubber stopper and two $\frac{1}{4}$-in. brass rods 8 in. long. The rubber stopper was drilled with two holes so that the brass rods fit into it tightly and the parts assembled as in the diagram.

When the jar was filled with distilled water and the assembled equipment connected to 120-volts a.c. a zero reading obtained. With raw river water in the jar the meter indicated 110 volts. We put a blank scale on the meter and placed zero at the position of the needle with distilled water in the jar. Another reading was taken with the jar filled with raw river water. We analyzed this water and marked the scale division with the grains of contamination per gallon.

Following this procedure we mixed several samples



of distilled water and river water to get various degrees of contamination and took reading with each sample. In this way we gradually constructed a meter scale that would at least give an approximate idea of how much the condensate is contaminated. After this had been done it was only a matter of determining from past experience what would be a safe working range on the scale of the meter.

The device contains several elements for error. The electrodes must be held firmly in the stopper, the height of the test sample in the jar and the position of the electrodes must be the same for each test. If the electrodes become fouled it will cause an error in the readings. The test samples must be taken with the same load on the unit or a correction made for unequal loading to avoid misleading readings.

With a little care, however, the equipment can be made to give a fairly good idea of the contamination in the condensate. If readings are taken daily, any sudden change in the character of the condensate will be detected, the cause found and corrected if necessary.

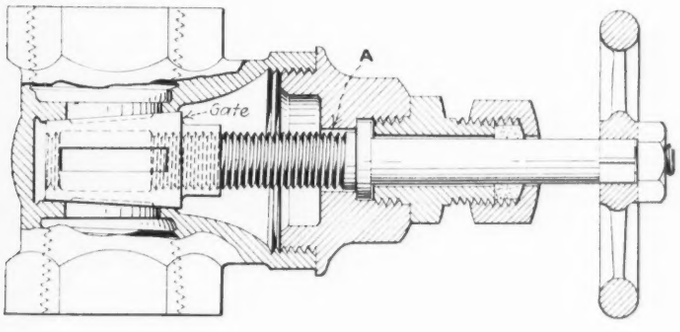
Because the amount of contamination in the raw water varies from time to time the meter readings are not a measure of condenser leakage, but of impurities in the condensate. For example, assume that because of high water in the river the impurities per unit volume decrease to one half of what they were before. Then, with the same leakage into the hotwell, the meter reading should show only one half the impurities in the condensate during high water or when the water is low.

Columbus, O. FRED E. SCHUBERT,
Chief Engineer
Municipal Power Plant

Repair Valves With Redesigned Stems

IT MAY be cheaper and better practice to replace old valves than to repair them in some cases, but in others repairing is the most convenient even if it requires quite extensive changes in the valve. The diagram shows the cross section through one of a large number of small gate valves used on water lines in the Whitehall Hotel. In many instances the valves are in the wall with only their tops outside for operation. To remove one of them would be an expensive and inconvenient job.

The stems in some of these valves started breaking in the thread. Because the valves are no longer manufactured parts could not be obtained. It was therefore a case of either replacing the valves with another make or providing new stems. The original stems were smaller than shown in the diagram and had a special double



thread, which would have been an expensive machine job to cut.

This problem was solved by selecting stock for the new valve stems larger than used for the old and then turning the top end to the original size. The valve end of the stem was made $\frac{1}{8}$ long than the original and threaded with a standard left-hand thread. The valve bonnett at A was bored out for clearance and the gates bored and tapped for the new stem. Some valves can be reconditioned in 20 to 30 min. compared to several hours' work to replace it.

New York, N. Y. A. HONORE,
Chief Engineer
Whitehall Hotel

CURRENT COMMENT

Forward Curved Fans In Parallel

THE main difference between Mr. Hagen and myself concerning the parallel operation of forward-curved fans is that case where they are operating at the peak of the static pressure curve, inasmuch as he has conceded that they will operate successfully at a higher ratio of capacity, that is, farther to the "right" of this static pressure peak. This is the case where there is only one intersection of his limit line and the fan static curve.

Another difference is his attempting to apply quantitative mathematics to a general fan curve. I did not state any forward-curved fan would operate in parallel. In fact, the original January article was qualified, whereas Mr. Hagen has attempted to demonstrate that no forward-curved fan will operate at this particular point in parallel.

That is my objection to quantitative mathematics applied to a general curve. The discussion becomes academic and the conclusions are misleading.

No two forward-curved fans have identical static-pressure curves. In fact, there is quite some variation of each fan, depending upon its specific proportions.

I can agree with the last paragraph of his summary for a general forward-curved fan, that one is likely to get into difficulty if it is not properly designed for parallel operation, but as I so stated at the outset, this fan can be so designed.

Detroit, Mich. M. S. KICE, JR.
Head, Industrial Division, American Blower Corp.

Slide Valve Engine Cutoff Governed

UNDER "Valves and Gear," page 314, June, *Power,* the second paragraph in the first column, there must be something wrong about your statement, "But with this valve governing is by throttling (an efficient method) and cutoff cannot be made to occur earlier than ⅝ in. stroke." We do not understand this. We furnish our engines equipped with flat or piston slide valves with either the throttling governor or the automatic governor. In the throttling type, the eccentric may be fixed or there may be a hand adjustable eccentric by means of which the cutoff can be changed when the engine is not running. Also the variable eccentric by means of which the cutoff can be changed manually while the engine is running. These two devices obtain economies with the throttling governor that are practically the same as secured with the automatic governor, in which case the cutoff varies with the load. If the cutoff could not be made to occur earlier than ⅝ stroke, we do not understand how the engine would govern."

Troy, Pa. F. J. VONACHEN
Troy Engine & Machine Co.

The statement referred to applies to a slow-speed engine. When cutoff with a single valve is made to occur earlier than ⅝ in. stroke, release and compression occur too early for good operation. With a high-speed engine, however, early release becomes desirable and permits cutoff governing. Early compression is taken care of by increased clearance. As the throw of the eccentric is decreased to obtain early cutoff, port openings decrease, which requires multi-port construction.—Editor.

How Wide A Gasket?

PERHAPS half the time I might agree with Mr. Novak's recommendations "How Wide a Gasket?" page 278, May *Power.* On the other hand, it seems to me that the additional width of gasket stock from the bolt circle outward provides material for withstanding the corrosive, solvent or otherwise gasket-attacking properties of the substances being confined.

With many gasket applications the design of the joint is such that the flanges are subjected to severe cantilever loading if the gasket stops at the inner edge of the bolt circle. This may cause a portion of the flange to be cracked off by one bolt being set up too tightly before load is put on the others.

In gasketing joints for handling highly-volatile petroleum products under pressures up to 1,000 lb. per sq. in., we have found it a safe rule to follow the flange manufacturer's practice. If a full-face gasket is called for the entire surface of the flange is finished in one plane. If a narrower gasket is advocated this is insured by machining clearance from the bolt circle outward.

Longview, Texas ELTON STERRETT

Broken Boiler Brace

I CANNOT agree with Mr. O'Regan when he states the simplest way to determine the safe pressure to carry with the brace broken would be to multiply the S.W.P. by 17/18. You cannot take the segment to be stayed as a whole but must take into consideration the area in which the broken brace is located. For when one brace is broken or cracked it immediately puts a strain upon the adjoining braces and not upon all of the braces in the entire segment. This additional stress might exceed the safe limit.

Why should a boilermaker be called in at the same time as the inspector to help make an inspection of the braces? Have you no confidence in the ability of the boiler inspector? If not and there is a reason for such lack of confidence it might be well to raise the standards for qualifying boiler inspectors.

I believe it is customary for makers of boilers to so dimension the holes in the shells and heads as to have standard braces already fabricated. In installing braces they drill holes in the head end and then heat the braces and properly fit them. Then mark off and drill the holes. at the other end. I do not think the braces should be installed as per Mr. O'Regan's view for when braces are cooled as outlined, they are under a severe tensile stress which is not good practice.

Mr. Hyler's reply causes one to inquire (it being understood I do not approve welding) why cannot a broken pressed-steel brace be welded if a broken rod-type brace can? Would the brace be prepared so as to weld all the way through or just what should be done other than already explained? Even though the brace were welded would it be safe? Assuming the length between supports does not exceed 120 diameters of the brace, welding a 1⅛ in. brace will reduce the allowable stress from 9,443 lb. to 5,964 lb.

Binghamton, N. Y. C. W. CARTER

No Quarrel With "Operating Engineers"

THE campaign of the engineering profession to restrict and protect, by legislative enactment, the use of the designation "engineer" is not directed or aimed at those who are popularly termed "engineers" because they operate locomotive, marine, or stationary engines. We should like to correct this confusing and conflicting application of the term "engineers," but we realize that this should be done by education and persuasion rather than by legislation.

Our legislative steps for the protection of our professional designation are aimed and directed at those others who misappropriate or misuse the appellation "engineer" in such manner as to mislead the public, degrade the designation, or injure the good name and standing of our profession. Other professions before us have found it necessary to secure legislation to protect their designations, and various professions have reached the conclusion that legal protection of the designation is even more important than legal protection of practice. This is for the safeguarding of the public as well as for the protection of the standards and the standing of the profession.

Without such legislation we cannot stop 1, those who mislead the public by appropriating the designation "engineer" in the professional sense, styling themselves as Electrical Engineers, Mining Engineers, Consulting Engineers, and the like, without professional education and qualifications; 2, those who are immature

or incompetent but who seek to facilitate securing employment by styling themselves "engineers;" 3, those who are not engineers in any sense and whose work is not engineering but who seek to borrow standing from the engineering profession by styling themselves "Sales Engineers," "Efficiency Engineers," "Insurance Engineers," "Service Engineers," "Social Engineers," and the like, and 4, those who display hybrid designations that degrade the term "engineer" or expose it to ridicule, such as "Lawnmower Engineers," "Matrimonial Engineers," "Domestic Engineers," and "Exterminating Engineers."

Our legislation is aimed at those who assume the designation with professional pretensions to mislead or in such forms as to degrade it. We are not primarily concerned with those who use the term "engineer" honestly, without professional pretensions or connotation, in the sense of an "engine operator" or "engineman." We do urge and recommend the adoption and substitution of these clarifying terms for the misapplied designation "engineer," and we have already made considerable progress through voluntary cooperation. Although we are not initiating legislation to this end, we are consistently opposing any legislation that tends to establish or perpetuate such equivocal or confusing use of the term "engineer" in the non-professional sense.

New York, N. Y. D. B. STEINMAN,
President,
National Society of Professional Engineers.

Another Suggestion for Indicating Water Level

THE idea suggested for using a cork ball to indicate the water level is new to me but I would not care to use it. When water fouls the gage glass it must be blown through, but how about the cork ball? It will be forced to the bottom of the glass and will shut off flow through the glass. It may also do a lot of other things to cause trouble, such as stick in the blowoff cock, or it may accumulate a deposit and stick in the gage glass.

There is a special gage glass made that has a red strip at its rear. The water magnifies the red so that there appears to be red water in the glass. Any one who wishes to prove the value of this idea may paste a strip of red paper on the rear of a common glass, protecting it with shellac, and note how clearly the water level stands out.

Cleveland, O. JAMES MCINTOSH

Welding Broken Boiler Stays

AMONG the answers in June regarding possibilities of welding a broken boiler brace, one description of a method of welding appeared.

It would be timely to give several excerpts from standard boiler codes. While they do not agree on some points in steam boiler rules, their similarity will be noted.

Quoting from the U. S. Dept. of Commerce Amended Rules and Regulations, No. S-21-4: "Repair welding shall be limited in its application to those cases where the stress is carried by other construction which conforms to the requirements of the code, and where the strength of the boiler or pressure vessel is not dependent on the strength of the welds." It goes further to state that "—No repairs by any process of fusion welding shall be permitted before an inspection is made by an authorized inspector and the proposed method of repair is sanctioned by him. . . ."

Turning to the Pennsylvania Regulations for Boilers, Section IV, rule G2: "Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the Rules formulated by the Department and where the safety of the structure is not dependent on the strength of the weld."

Third, the Industrial Code of the New York Dept. of Labor, General Requirement No. 14-8.3 reads: "Fusion welding, except as otherwise permitted by these rules, shall be limited in its application to those cases where the stress is carried by other construction which conforms to these rules and where the strength of the boiler or vessel is not dependent on the strength of the weld."

Other codes read practically the same. Engineers in formulating these codes had good reason to forbid welding of braces. While the question of obtaining proper tension is difficult, the doubt of the efficiency of the weld is most important. It is possible to make a weld stronger than the base metal, but the only way to be positive of it is to stress-relieve and examine for defects with X-ray. The A.S.M.E. Code permits welding if this procedure is followed, but obviously, this would be uneconomical compared with the cost of installing one new brace.

If welding of one brace to give it proper strength is permitted, it would be logical to allow any number, or all braces to be welded. The strength efficiency of many welds that appear satisfactory on external surfaces has been proved by test to be below 50%. By such action, the safety of the boiler at its formerly allowed pressure would be impaired seriously.

The answer given by Charles W. Carter, Jr. is a good one, and entirely correct.

New York, N. Y. HARRY M. SPRING

Notes on Diesels

E. J. Tangerman, associate editor, happened in on Mr. Candlish the day after the following discussion had been mailed in. Further talk with Mr. Candlish brought out that many of his remarks refer to small European diesels, mainly for transport use, while the author had in mind stationary-power units of appreciable size. However, most of Mr. Candlish's points are of sufficient general interest to warrant publication.—Editor.

THESE notes were made after reading through the article on diesels in June *Power*. I would like to correct some of the statements made. The first is on piston speeds. The modern high-speed diesel has piston speeds beginning at 1,500 f.p.m. and ranging upward to 3,600. Speeds in r.p.m. frequently top 4,000. Variable-speed engines operate through a range of from 375 to 3,000 r.p.m. or from 400 to 3,500 r.p.m.

The solid-injection engine does not necessarily require high-grade fuel; it will handle any grade of fuel that the air-injection engine will handle, except coal. The solid-injection engine *is* more sensitive to its fuel. The same nozzles or atomizers will not handle widely differing grades. In other words, a light-fuel atomizer may not be satisfactory with a heavy, sticky fuel. In extreme cases the condition may affect the fuel-injection pump. All this, however, can be easily overcome by proper design. Due to poor design in some solid-injection engines, it has been necessary to call in oil refiners to develop special grades of fuel in order that the engines will operate satisfactorily, but temperamental engines, calling for special fuel, can only result in higher costs, thus defeating the advantage of a good diesel. A good engine does not require an expensive fuel, nor is it smelly nor smoky. That is purely up to the designer. Many cases of objectionably smelly and smoky engines can be traced to attempts to increase brake-hp. output beyond the capabilities of the design.

The third statement with which I disagree refers to the fact that the 2-cycle engine avoids valves, inferring greater simplicity. There are now relatively few simple 2-cycle engines. Long ago theory dictated, and later experience has proved, that valve-timing and piston action are quite out of phase. Therefore, to obtain the best possible output recourse has been had to scavenging systems, thus offsetting the disadvantages of out-of-phase timing and piston action. However, the complication of the added scavenging system more than offsets the elimination of valves, although the scavenging system does improve volumetric efficiency to a point of providing a mild supercharge, thus giving higher b.m.e.p. On the other hand, an ordinary 4-cycle engine will show higher b.m.e.p. than a simple 2-cycle diesel.

The fourth statement is that fuel-pump plungers measure the fuel. That is only true in the case of a variable-stroke pump. In this type of pump there is no spill valve, so the amount of fuel is measured by varying the length of the stroke of the plunger under control of the throttle or governor. In the more modern, constant-stroke, fuel-injection pump the plunger always delivers the same amount of fuel. The spill valve in turn, under control of throttle or governor, regulates the amount of fuel delivered to the cylinder.

The limits on fuel-injection pressure are wrong. This pressure varies from 1,000 lb. per sq. in. to, in extreme cases, 20,000 lb. per sq. in. Lower pressures are found in those engines in accord with the laws of physics and nature, higher pressures in engines where nature is given a battle for no good reason. There are still some engines using mechanically operated fuel valves, although quite few now.

All fuel valves are not multi-orifice by any means, particularly in small engines. Whether a single- or multi-orifice nozzle is used is purely a matter of combustion chamber design, and fuel used. Small multi-orifice nozzles tend to clog, unless particular pains are taken to insure clean, well-filtered fuel.

Contrary to the article, nickel-chromium cast-iron liners are not always fitted. This is an excellent material, but wide use is made of centrifugally cast

iron, hardened high-carbon steel and Nitraloy steel. The selection of material is one of cost or hours of operation expected between liner replacement. Many cheaper engines do not use liners, but still offer integral cylinder and jacket.

In reference to supercharging, the limiting b.m.e.p. for the ordinary diesel operating on commercial fuel is 183 lb. per sq. in., assuming unity volumetric factor and complete use of all air in the cylinder. Very few engines today give better than 120 lb. per sq. in. b.m.e.p., while most are much below 100 lb. per sq. in. Many are below 80 lb. Therefore, there seems to be ample room for improvement. When we have cut this margin without smell and smoke it will be time to think of going to the expense of supercharging. Further, the entire bearing pressure range can be much lower with a natural aspiration than with a supercharged engine for a given reasonable and possible b.m.e.p. It would seem logical then, to leave supercharging out until power demands per unit require it. Although we have an almost unlimited number of designs, the combustion chamber as the ideal has not yet arrived. Some are good, many are bad, some very bad. The ideal chamber would give maximum thermal efficiency, maximum use of available air, minimum unburned products, and be entirely automatic in its function relative to speed, i.e., it should not require change of injection period with changes in engine speed.

The diesel is still in a belated infancy, due to the lack of proper knowledge to develop it. It will, however, only be developed along sound engineering lines. Many of the trick designs now used for diesels first made their appearance in the early days of the gasoline engine. I predict they will be no more successful in the diesel than they were in the gasoline units.

Sandwich, Ont. BOYD CANDLISH
Engineer

Water in Superheater Hurts Dry Pipe

I HAVE noted with interest the article "Dry Pipe Explodes Inside Steam Drum," page 335 June, *Power*. Some years ago the writer supervised the installation of superheaters in what was then the largest boilers fired with pulverized coal in New York City, the units of which were of the non-drainable type. Shortly after the first boiler was placed in service and then taken down for inspection, the cast-iron steam dryer in the drum was found scattered throughout the length of the drum.

This was puzzling to the operating personnel until the matter of the non-drainable units was hit upon. It was then realized that when firing up, opening of the drain at the superheater outlet was overlooked. This resulted in steam generated in the unit forcing the water left in them, following the hydrostatic test, back through the connecting pipe and bursting the dryer.

The A.S.M.E. Code on drains for superheater, page 99, P-306, states that each superheater shall be equipped with at least one drain so located as will most effectively provide for the proper operation of the apparatus. The practice is to apply one drain at the superheater outlet. It is my opinion that a drain should also be applied to the superheater inlet at the lowest point of the connecting pipe, especially when a long connecting pipe is provided where superheaters are installed interdeck on H.W.T. boilers.

Bogato, N. J. E. C. GRIEF

READERS' PROBLEMS

QUESTIONS for Our Readers

Cause of Pounding Pump?

Question 1

AT OUR *plant we have three 600-hp. Corliss engines and a turbine exhausting into a header which supplies steam to a 50,000-lb. open water heater and a 3,000-sq. ft. vacuum heating system. In connection with the heater there is a 14-in. back-pressure valve set to open at 3-lb. back pressure. When all three engines are operating at capacity the back-pressure valve is held open, but when the turbine alone is running there is not enough steam to maintain pressure in the exhaust header. Under these conditions, that is, with the turbine alone in operation, the pumps feeding the water heater begin to pound. Can some of POWER'S readers tell me what causes this action and what I should do to stop it?—T.P.*

Change Head on Pump?

Question 2

WE HAVE *a centrifugal pump rated at 300 g.p.m. against a 100 ft. head and wish to use it where the head is only 60 ft. Can the pump be used for this head, if not what changes are necessary to make it satisfactory? The pump is connected to a 10-hp., 1750-r.p.m. induction motor and I am told that if the head is reduced on the pump the motor will be overloaded. If this is true, why is it?—R.W.G.*

Suitable answers from readers will be paid for if space is available for publication.

STATIC RUINS OILCLOTH

ANSWERS to June Question 1

The Question

WE OPERATE *a table oilcloth plant and have experienced considerable trouble with static electricity collecting small pieces of wood and grease on the surface of the oilcloth during the drying operation. We have tried several methods of removing this static, but have not yet eliminated the trouble, and will appreciate any suggestions from readers of POWER.—M.C.D.*

Neutralize Static With Electric Field

STATIC is produced by the intimate contact of two dissimilar substances. It appears in the form of electrical charges which are static, and these charges may be of a positive or negative polarity and of various degrees of intensity. Such static charges can be rendered ineffective under all conditions by bringing them into contact with equal and opposite charges.

M.C.D. can neutralize the static on his oilcloth by maintaining an alternating electrical field of from 10,000 to 15,000 volts through which the cloth should pass during the drying process. In passing through the field the static charge on the oil cloth, whether negative or positive, is neutralized by the neutral affinity it has for an equal amount of the opposite kind of charge. Commercial equipment is available for applying this principle and has been used in the printing of oil cloth as well as many other kinds of material.

New York, N. Y. G. C. WILLIAMS

Uses Tinsel To Remove Charge

STATIC electricity creates a great deal of havoc in printing plants, especially in dry climates. Two cures that we employ in our plant may be helpful to M.C.D. The first is to increase the humidity. Apparently a slight increase in the moisture content of the paper increases its conductivity enough to prevent a static charge from building up in the sheets. In addition to increasing the humidity, we hang a grounded piece of Christmas-tree tinsel so that it brushes over the sheets of paper just before the point where the electricity caused trouble. This tinsel acts like the brush on a commutator to carry the charge from the paper to ground.

New York, N. Y. F. JERRY

Remove Charge With Wire

WHILE we are not sure what kind of a layout M.C.D. has for drying oilcloth, it is assumed that it is run over rollers, and that either the rollers are heated or that they carry the oilcloth through a heated area. If this is the case, doubtless the static is caused by the oilcloth creeping to some extent on the rollers, causing friction.

In general, it would seem that the same solution could be used here that has been used in the case of a transmission belt running in an explosive atmosphere, where it was feared that sparks jumping from the belt might cause an explosion. A solution that has been used in such a case is that

of weaving a wire back and forth through the belt, so that the wire runs all the way around the belt, and then running the belt over a steel pulley at the lower end, so that the static charge could be drained away by grounding the pulley, the wire coming into contact with the pulley all of the time.

Wire could not be woven through the oil cloth, of course, but it might be possible to run the oilcloth over a rider belt in which such a wire could be woven. If such an arrangement could be made, it would seem entirely possible to drain away the static charge on the oilcloth as fast as it developed. Possibly some adaptation or variation of this idea might lead to a solution.

Peoria, Ill. JOHN E. HYLER

Will Superheat Hurt Engines?

ANSWERS to June Question 2

The Question

WE HAVE *three 500-hp., 4-valve engines operating on saturated steam at 175 lb. pressure. It has been suggested that we could improve our efficiency by installing superheaters and operating the engines on superheated steam. There is sufficient room in the boilers to install enough surface for 180 deg. of superheat. I am concerned, however, about the effect of the higher temperature on the engines and shall appreciate comments concerning the operating troubles we are likely to encounter? Do any changes have to be made to the engines?—G.W.D.*

Ask Engine Manufacturer

UNQUESTIONABLY the use of superheated steam will bring about a material improvement in the steam economy of the units in question; however, there are certain factors which must be given careful consideration before superheated steam is used.

The complete name-plate data of the engines in question should be referred to the manufacturer of the engines to see what superheat the valve gear, cylinders and pistons will withstand without changes. Very likely, and it has been the writer's experience in such a case, a new cylinder, piston and valve gear will have to be applied to the engine, if of the uniflow poppet valve type.

A careful inspection should be made of the piping to ascertain whether the valves and fittings will withstand superheated steam. Cast iron has the very bad habit of growing under high-temperature conditions.

Cedar Rapids, Iowa JOHN M. DRABELLE

Don't Use Over 75-Deg. Superheat

I HAVE recently been identified with a property confronted with a situation similar to G. W. D's. They have engines well advanced in age, with cast iron cylinders, originally designed for 125-lb saturated steam. These engines have various types of valves and some of the cylinders have been re-bored more than once. An investigation to determine the highest steam temperature permissible indicated the superheat should be held to not over 50 deg. at 110 lb.

A development on the property brought about the condition that these engines have been supplied for the past 4 yrs. with steam at 110-lb pressure and 30 deg. superheat and this superheat has caused no trouble in engine operation.

It was anticipated it might be necessary to change the quality of the engine cylinder oil and that possibly more oil might be required under the new steam conditions. It did become necessary to use a better grade than previously, but the quantity of lubricant required decreased, probably due to use of a better grade.

It is my judgment that a maximum steam temperature of 450 deg. is practical, assuming the engine cylinders are made of cast iron. This is a superheat of about 73 deg. at 175 lb. pressure.

The effects of higher steam temperature on cast-iron engine operation are, in order of appearance, (1) increase use of engine cylinder oil and (2) gradual growth of cylinders and pistons as well as possible growth of certain types of cast-iron valves that may result eventually in the valves sticking. With superheated steam better quality oil than used with saturated steam will prevent some troubles while moderate superheat will obviate other troubles. Consequently, directly answering G. W. D., he may use 75 deg. superheat without expecting engine trouble initially or eventually, providing at all times a cylinder oil is used that will withstand 450 deg. without breakdown of film strength and that will not carbonize at this temperature.

Greater than 75 deg. superheat in this case will not assist materially in attaining greater engine efficiency nor reducing steam consumption. All that superheat can do in engine operation is to decrease initial condensation, unless the engine is compounded and the low pressure end, either an engine or a turbine, exhausts at less than atmospheric pressure.

New York, N. Y. W. S. JOHNSTON

Readjust Valves

SUPERHEATED steam will not hurt engines if properly handled. The first change to be made when changing from saturated steam to superheated is the lubrication. You must have a higher fire test oil to take care of the higher temperature of the superheated steam. The next change to be made is in the valve setting. You can have earlier cutoff and less compression when using superheated steam than when using saturated steam. This is due to the lack of condensation with superheated steam, and it will require a higher grade of packing for the piston rods and valve stems. I think it would pay to install the superheater. Superheated steam is more efficient than saturated steam.

Fort Wayne, Ind. JOHN L. WHITE

Change to Metallic Packing

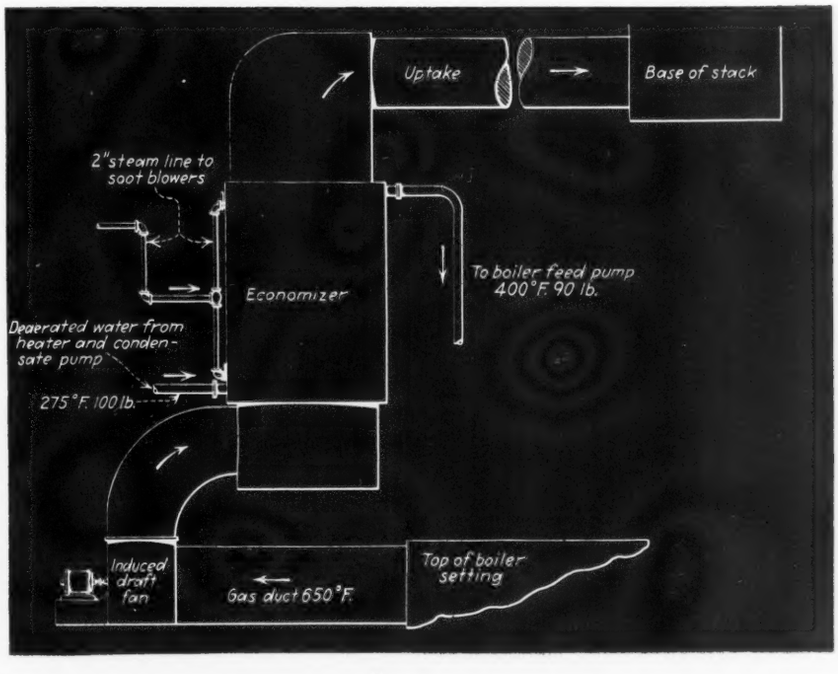
THE USE of superheated steam in engines always results in some gain usually averaging about 1% fuel saving for each 10 deg. of superheat. Whether the expense of installing and maintaining the superheater is justifiable can only be determined by comparing such expense with the value of the fuel saving which is effected by superheating the steam.

Definite information cannot be given because no mention is made of the type of valves, whether piston, Corliss, or poppet,

WHAT'S WRONG WITH THIS PICTURE?—VI

ECONOMIZER INSTALLATIONS

THERE are at least 15 mistakes shown in this drawing. Make a list of those you can recognize, then check against the list on page 452



etc., and specific type of engine. Four valve engines are made in about five different types and by many builders.

Valves and seats for use on superheated steam are made of cast iron, cast steel, monel metal and bronze. Hard metal seats and disks are necessary due to the greater cutting or wire-drawing action of the superheated steam when the valves are partly open.

Cylinder oil for engines using superheated steam must be of a quality that will not decompose at the high steam temperature, but less oil is necessary due to less condensation on the cylinder walls. In some types of engines, a change in the method and place of feeding the oil is necessary when changing from saturated to superheated steam.

Metallic packings are usually used on the glands of engines using superheated steam as the soft packings will usually not stand the high temperature. It is often necessary to lubricate the packing glands with oil under pressure.

The type of engine determines the amount of superheat at which it will operate most profitably. For example, compound and multiple-expansion engines benefit more by higher steam pressure than they do by superheat. The practice is with this type of engine to use relatively high pressures and little superheat. For simple and uniflow engines the use of high superheat is very economical.

Stationary engines using highly superheated steam usually have poppet valves and may operate up to about 600 deg. Piston type valves will operate up to about 570 deg. The Corliss up to about 500 deg. and the flat slide valves will operate up to about 390 deg.

Advantages of superheated steam are: increased engine efficiency, decrease in the amount of oil needed, less weight of steam for a given amount of power, decreased cylinder condensation and trouble with water in engine cylinders, decreased radiation and pressure losses.

Disadvantages are: additional equipment to superheat the steam, better grade of oil, higher temperature packing, possible changes in the size and shape of cast-iron parts.

If impure feed water is used, dust may be carried from the superheater to the engine. This is usually the case with a foaming boiler. After a quantity of dust accumulates in the superheater some of it will be carried away with the steam which passes to the engine. The mineral dust is a good abrasive and will probably score the engine cylinder.

Waynesboro, Va. J. M. Myers

Change Lubricant

With a steam pressure of 175 lb., 180 deg. superheat will mean a total temperature of 557 deg. and if the engines are of the poppet-valve type no trouble should be experienced, but for other types of valves a temperature over 450 deg. is not advisable. No changes in the engines will be necessary but a different lubricant for the cylinder will have to be used, one with a flash point of over 550 deg. and a viscosity at 210 of over 160 sec.

The size superheater to install can only be arrived at by balancing the cost of the superheater against the possible saving in the steam consumption of the engines. There will be an increase in capacity also. Assuming 10% increase in economy with 90-deg. superheat, the expected increase with 180-deg. superheat is about 15% and since the second 90 deg. yields only half the returns of the first 90 deg. and since a moderate superheat will not occasion any operating difficulties, it might be wiser to install only half the superheating surface permitted by the boiler setting. If, however, the full capacity can be installed at small additional cost, or if the advantages of superheated steam appear very promising, then this course could be followed, and if later, operating difficulties are encountered with the high superheat, part of the superheater surface could be removed or blanketed.

Chicago, Ill. N. T. Pef

Inspect Piping For C. I. Fittings

It is considered good engineering practice to use all the superheat the equipment will stand. However, a plant designed for saturated steam at 175 lb. pressure will present many difficulties in the use of any high superheat unless superheat was contemplated and provided for in the original installation. The greatest objection is the fact that cast iron is not reliable when subjected to the higher temperatures of superheat and if the piping system of the plant in question has the usual extra-heavy cast-iron fittings and valve bodies, they should be changed to steel before subjecting them to any high degree of superheat.

As for the effect of superheat on the four-valve engines, the manufacturer should be consulted and his advice given careful consideration. This also applies to the auxiliary equipment such as boiler feed pumps, etc.

Economy to be expected by operating at say 100 deg. superheat would in all probability be offset by the cost of the necessary changes.

It must not be inferred from the above that the use of superheat should be abandoned entirely. A small amount will prove very beneficial and should show an appreciable reduction in steam consumption.

If sufficient superheating surface were installed in the boilers to provide dry steam at the throttles, I am sure the results would be most gratifying and no major changes in equipment would be necessary. If the exhaust steam is used for process work, sufficient superheat could be provided to insure a practically dry exhaust with most beneficial results.

Should the above suggestion be adopted, a check up on the lubricant and packing should be made although it is hardly likely any change would be necessary.

New Rochelle, N. Y. Andrew B. Duryee

WHAT'S WRONG WITH THIS PICTURE?—VI

ECONOMIZER INSTALLATIONS—SEE PAGE 451

This article points out errors in design, installation, and maintenance of economizer installations. For simplicity, the sketch and list of mistakes are confined to the general set-up, piping, and lack of instruments necessary for proper operation.

1. *No Relief Valve.* A relief valve should be provided to prevent excessive pressures in the economizer.

2. *No Blow-down Valve.* A blow-down valve should be provided at the lowest point in the economizer or water piping to remove sediment and sludge accumulations.

3. *No Soot Removal Doors.* A door or duct should be provided in the lowest point in the soot hopper to facilitate soot removal.

4. *No Pressure Gages.* A pressure gage should be provided at both economizer water inlet and discharge to check on internal conditions.

5. *No Thermometers.* Thermometers should be installed on water inlet and discharge to check on economizer efficiency and tube cleanliness.

6. *No Temperature Instruments for Gases.* Temperature indicators or recorders should be provided on gas inlet and outlet of the economizer. These instruments are a great aid in checking heat absorption efficiency.

7. *Feed Pump on Wrong Side of Economizer.* While the feed pump is placed after the economizer in some older installations, the feedwater temperature indicated would preclude any practicability of such an arrangement in the case illustrated.

8. *No Draft Gages.* Draft gages should be provided at the gas inlet and outlet. These serve to check the friction loss of gases through the economizer, and they may detect any serious air infiltration.

9. *No Vent.* A valved vent at the highest point of the economizer serves to eject air when filling, and as a vacuum breaker when draining.

10. *Induced Draft Fan in Wrong Place.* Induced-draft fan should be between economizer and stack so it will handle a smaller volume at lower temperature gas.

11. *No Damper.* A damper should be provided to aid in draft control under certain operating conditions.

12. *Soot Blower Supply Line Too Small.* This line should be enough larger than individual branch lines to prevent excessive friction drop when operating soot blowers.

13. *No Stop Valve on Soot Blower Line.* An independent stop valve should be provided to permit shutting off steam pressure when repairing soot blower valves.

14. *No Stop Valves on Water Lines.* Stop valves should be provided on inlet and discharge lines, as near as practical to the economizer.

15. *No Soot Blower Drain.* A drain valve should be provided at the lowest point in the piping near the stop valve. Failure to remove condensate from the piping before blowing soot will cause the soot to be wet down and impossible to blow off.

New York N. Y. Harry M. Spring

A. S. H. V. E. AND A. S. R. E. MEET IN POCONOS

THE SEMI-ANNUAL meeting of the American Society of Heating and Ventilating Engineers, held June 22 to 24, at Buckhill Falls, Pa., was unusually well attended, over 350 members and guests having registered. The American Society of Refrigerating Engineers also held its spring meeting a few miles away at Skytop on the same days. This made possible a joint session at which air-conditioning, a subject of interest to both societies, was discussed.

At the first technical session two papers were presented of interest to power engineers; one a paper on "Corrosion Studies in Steam Heating Systems," by R. H. Seeber, F. A. Rohrman and G. E. Smedberg. The other, "Distribution of Steam in Heat Transfer Surfaces," by John McElgin.

The corrosion paper, presented by title at the society's annual meeting in January, reported work done at the Michigan College of Mining and Technology, and was briefly abstracted in the March number of *Power*. Curves were presented showing the effect of pressure, temperature, rate of flow, oxygen and CO_2 on corrosion rates, and an electric resistance tester to determine rate of corrosion from a shorter test interval than possible with the N.D.H.A. tester described.

The paper excited considerable discussion. W. H. Driscoll, of Thompson-Starrett Co., exhibited samples of corroded pipe taken from a large New York hotel built about five years ago. All samples were taken from the steam heating line. Other discussion brought up the question of increased corrosion with combinations of different metals, and Mr. Seeber indicated that aluminum and copper could not be used together without corrosion resulting. It was suggested that the investigators were overlooking the possible erosion of metal due to cavitation. Mr. Finigan, of the New York Steam Co., suggested that no attempt should be made to correlate corrosion rates determined from testers with life of pipe.

Temperature Stratification

The paper, "Distribution of Steam in Heat Transfer Surface," pointed out that difficulties encountered in the application of automatic temperature control to finned-tube steam-heating surfaces are a direct result of temperature stratification created when air is by-passed or when steam supply is modulated. In the first the condition is generally fundamental to the process, while in the second it is due to complete condensation of steam in a section of the heating surface next to the steam supply. A finned-tube heating surface was described in which temperature stratification was greatly reduced by inserting steam distribution tubes within the usual condensing tubes. This arrangement permits throttling of the steam and serves to distribute the reduced volume over the length of the condensing surface, so effecting a practically uniform temperature of the air discharge from the heater. It also inherently resists freezing of the condensate in the heating surface.

The discussers seemed to think that the emphasis placed on stratification was not warranted, and inquired as to whether there was any difficulty in eliminating air from heaters arranged with these steam distribution tubes. S. Lewis described how he had eliminated trouble from stratification in a unit heater by using a heater of the type described.

Heat Pump

At the joint session of the A.S.H.V.E. and A.S.R.E., C. W. Chamberlain presented a paper, "Principles and Practice of the Heat Pump," which caused considerable comment and discussion outside of the meeting, even though there was little discussion from the floor. The first part of this paper dealt with a discussion of early forms of heat pumps and described a new heat pump cycle that can be used for heating, cooling and ventilating. The latter part of Professor Chamberlain's paper related the results of experiments made to determine the characteristics of surface films that resist heat transfer. These films have been observed with the aid of a compound interferometer and found to have a minimum thickness of 1.5×10^{-7}cm. This is the distance over which molecules act, and is called the radius of molecular attraction, and indicated by the letter R.

Films one R thick have been found to cover all surfaces and may be composed of air or any other gas, but generally consist of water from the atmosphere. They are always the same thickness whether composed of air, water or oil. The pressure in these films is very high, increasing the density of water to 1.1. The barrier films are very persistent and exceedingly hard. An attempt to cut the film on the surface of cast iron with a cold chisel and hammer results in the crushing of the iron without rupturing the film.

Thin liquid films have been found to have a laminated structure. The surface layers, 1-R thick, appear to be a gradual transition from the liquid to the vapor stage, and most important of all, molecular impact with these surface layers appears to be inelastic rather than elastic. These characteristics Professor Chamberlain used to design a new type of heat exchanger for use with air and liquid. This heat exchanger contains a column of foam and the air moves upward through it. The heat-absorbing liquid is supplied at the top, and when it strikes the column of foam each separate globule of liquid is seized, smashed into a thin sheet and passed downward with surprising velocity. The foam walls all split in the middle and the liquid contacts all of them. There is thus a rapid thermal interchange between the downward moving liquid and the thin foam walls, and from the latter to the upward moving air.

J. R. Hertzler presented a paper, "Application Factors Which Govern the Selection of Refrigerating Equipment for Air-Conditioning Service." The paper dealt with refrigerating equipment using Freon. He concludes that the load factor and the actual loads at which the equipment will be required to operate determines the number of compressor units and the capacity regulating devices. Amount of condensing surface justifiable is variable and depends upon the balance of first and operating costs that results in lowest annual expense.

Two other papers were presented at this joint session. One by D. C. Morrow briefly pointed out that air-conditioning was greatly increasing the demand for cooling water and increasing the load on city water supply systems. The other, a rather extensive paper by W. H. Carrier, detailed the progress of air-conditioning during the last quarter century.

At the final session two papers were presented of interest to readers of *Power*, one "A Field Study of the Heating Requirements of a College Building," by F. E. Giesecke and W. H. Badgett, and the other, "Heating Requirements of an Office Building as Effected by Weather Conditions," by F. C. Houghten and Carl Gutberlet. The first describes tests made at the Agricultural and Mechanical College of Texas, to determine how closely the estimated heating requirements of a building, as calculated by methods given in the A.S.H.V.E. guide, come to the actual heat requirements. The building tested was heated by hot water and arrangements were made so that the heat input to the building could be closely measured. Results of observations made during seven complete 24-hr. periods indicate that the estimated heat requirements averaged about 23% higher than the actual heat requirements of the building.

After these results, the cracks between the steel sash and frame of a large number of windows were measured and found to be smaller than assumed. Consequently, the infiltration of air around the windows was corrected to more nearly conform with the actual cracks which resulted in reducing the estimated requirements to within 12.6% of the actual.

In discussion, Mr. Timmis expressed the opinion that the air change method of calculating heat loss due to infiltration was at fault and should be abandoned.

Effect of Weather

The paper on the effects of weather on heat requirements of an office building is a second report on observations made on the Grant Building in Pittsburgh, the first paper being presented in 1934.

The study briefly indicates a considerable reduction in heating requirement of the rooms on upper floors below that required for rooms on lower floors due to the chimney effect of the building.

It is shown that the sun effect on the heating requirement of rooms subject to solar radiation is considerable and varies from no effect on cloudy days to a very large effect on days of more intense radiation. The percentage of solar radiation impinging against the glass of the window in a given room, which is effective in heating that room during the usual heating period averages about 50%.

150 ENGINEERS TALK DIESELS AT

OVER 150 engineers and their wives attended the Ninth Annual Oil & Gas Power Meeting of the Oil & Gas Power Division, A.S.M.E., at the University of Michigan, Ann Arbor, June 24-27. Thirteen papers were presented at six technical sessions, and there were also two inspection trips, one of Ford Motor Co., the other of Greenfield Village (*Power*, pages 26-27 Jan., 1934). A dozen exhibitors showed their products.

At a general session on Wednesday afternoon, Prof. F. C. Hechler, of Penn State College, in "Diesel Engineering Training," reported that a questionnaire sent to 110 colleges brought 76% reply and showed student interest in diesel training in 63, industry interest in such training in only eight, some interest in twelve more.

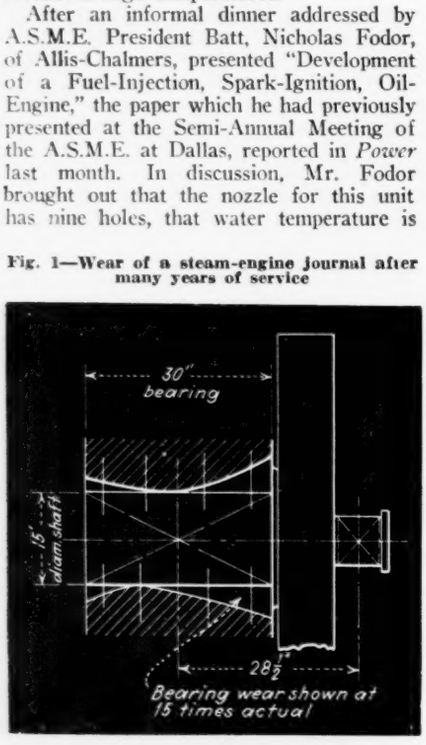
Correspondence courses, night school work, and similar training are also now being offered by colleges at modest fees. Montana State College, for example, this year conducted a 10-week short course for 38 students at $25 per man, and also had 15 night-school students. Public schools in Butte, with federal aid, gave 27 hours of instruction to 94 men actually working on diesels, charges being $10 per man.

In discussion, E. T. Vincent, of Continental Motors, disagreed with Professor Hechler's findings. Mr. Vincent felt that industry was in a position to absorb many well-trained men in preference to developing a training course in the factory. R. E. White, of Hemphill Diesel Schools, explained the training method followed by his schools. Oliver F. Allen felt that technical post-graduate training should be centered in a few of the universities, which schools could then build up a complete course comparable to European engineering courses.

"Research Activities at the University of Michigan," by A. E. White and C. W. Good, was followed by an inspection trip of spectroscopic control in the foundry, shock absorber lubricants, and behavior of metals at high temperatures.

After an informal dinner addressed by A.S.M.E. President Batt, Nicholas Fodor, of Allis-Chalmers, presented "Development of a Fuel-Injection, Spark-Ignition, Oil-Engine," the paper which he had previously presented at the Semi-Annual Meeting of the A.S.M.E. at Dallas, reported in *Power* last month. In discussion, Mr. Fodor brought out that the nozzle for this unit has nine holes, that water temperature is thermostat-controlled to 150 deg. at the outlet, and that the engine burnt No. 3 furnace oil. Good diesel oils have been found "too good." E. T. Vincent, of Continental Motors, doubted the advantages of the engine, and said that it served no useful purpose that the diesel could not fulfill. He also explained that many diesel troubles are faults of "hereditary" designing. He mentioned one case in which the maximum explosion pressure in the diesel is only 650 lb., instead of the 950 quoted by Mr. Fodor, and in which fuel consumption is only 0.37 lb. per b.hp.-hr., or 0.39 lb. per b.hp.-hr., with accessories. Mr. Fodor explained that the new engine will burn a wider range of fuels than diesels in the same field, and can be built more economically.

Fig. 1—Wear of a steam-engine journal after many years of service



Bearing Design

In "Bearing Design," Harte Cooke, of McIntosh & Seymour Corp., discussed design policies of his company on steam engines they formerly built. The general idea was that a bearing should be about twice as long as its diameter, and the product of the pressure per square inch on projected area multiplied by its rubbing speed in feet per minute, should not exceed a certain figure. The shaft was designed so the stress in the extreme fibres did not exceed about 7,000 lb. per sq. in. Recently one of the engines was opened up and its bearings checked, with the results shown in Fig. 1. The engine was a 19x38x48-in. double tandem-compound. It operated at 135-lb. steam pressure at 100 r.p.m., and 148-i.hp. The diagram shows that the shaft near the disk deflects in the neighborhood of 0.020 in. on both forward and return strokes, and that the shaft deflects all the way to the other bearing.

Remedy

This ultimately suggested the remedy of making the bearings shorter and larger in diameter, even though it cut fibre stress at outer fibres well below the 7,000 lb. originally thought desirable. The increased rotary speed thought at that time to be a disadvantage probably was a help, as it assisted in building up a better oil film. Bearings should be so designed that the deflections due to such forces as come upon them are within limits that can be taken care of by the supporting oil film. This points to the bearings large in diameter and of short length.

In discussion, E. T. Vincent mentioned experiences with roller bearings on a crankshaft, in which shaft flexure caused continual failing of the bearings until self-aligning roller bearings were used. Mr. Brown, of Bohn Aluminum Co., believes that much bearing wear is due to deflection of the crankcase. Mr. Cooke suggested that trouble with crankpin bearings may be due to overloading brought about by hydraulic pressure of the lubricants, explaining that using the same viscosity oil when engine speeds are doubled also doubles hydraulic pressure. Max Hofmann, engineer of Waukesha Motor Co., stated that his company had reduced bearing wear by stiffening the frame. Mr. Freeman suggested that rebabbitting possibly distorts the shell, and then the shell is not checked for distortion before being returned to the housing, as it should be.

Prof. G. T. Wilson, of the University of Wisconsin, discussed "Engine Governors." Much of the material is similar to the article in *Power*, "Governing," page 329, June number.

R. A. Kaufmann and W. T. Berkshire, of General Electric Co., prepared "Characteristics of A.C. Generators for Parallel Operation When Driven by Internal Combustion Engines," presented by Mr. Kaufmann. Conclusions were: Important characteristics involved in paralleled engine-driven generators include all those performance characteristics normally considered in any application, such as efficiency, first cost, size, weight, reliability, simplicity, etc., and, in addition, those characteristics which have a bearing on the control of pulsating torque.

The ratio of pulsating torque to impress torque is primarily governed by the ratio of impress frequency to natural oscillating frequency, the latter being established by the ratio of synchronizing torque to moment of inertia. The generator synchronizing torque constant, however, is a direct function of the stiffness of the magnetic system. For full utilization of electrical and mechanical material, the constant is quite invariable. Objectives for minimum pulsating torques or currents are control of the natural oscillating frequency, largely by adjustment of the inertia constant and reduction in the magnitude of the impressed torque harmonics. Reduction of that component of light flicker which is the result of torque harmonics from the engines must depend primarily on control of inertia constants and engine torque harmonics to maintain speed variation below values allowed by an accepted flicker sensitivity curve, Fig. 2. The presence of synchronous or induction motor load equipment in general functions to produce a voltage variation which is smaller in magnitude than the corresponding speed variation. However, this variation can rarely be considered as a true corrective influence, as it is quite often necessary to deliver power to the lighting system without the assistance of the motor load to reduce flicker effect.

Governing

In discussion, Mr. Barnaby, of the Worthington Pump & Machine Co., brought out that the primary need for close governing was a result of development of the electric clock rather than of any need for keeping machines in step. Mr. Cooke described a governor for an old 10,000-hp. steam engine which had 22 leaves, ⅜ in. by 8 in. by 18 ft. for the longest, in which the springs alone weighed 700 lb. apiece. He believes that the primary difficulty is in not making governors big enough to handle their job. C. R. Alden suggested that the proper governor arrangement is a combination using centrifugal control for high speeds and vacuum governing for idling loads. O. F. Allen brought out that safety devices should be kept independent of the speed control governors, and men-

ANN ARBOR MEETING

tioned one case of a small unit in which the governor cost more than the generating system complete.

Thursday afternoon, C. M. Larsen, of Sinclair Refining Co., gave "Performance of Lubricants Based on Service Conditions." After pointing out the variations in lubricating oils specified by various manufacturers, he brought out that in several instances where it was impossible to increase oil capacity, excessive sludge trouble was eliminated by increasing the rate of circulation and putting in oil coolers. The increased rate of circulation of cooled oil reduced the piston and ring temperature so that less oxidation and cracking of the oil occurred, and blow-by was reduced because better piston seal was maintained. Formerly, heavier oils were tried, but the condition became worse because of the higher temperatures and the more sluggish oil flow. High end point, high carbon content, or low ignition quality in a fuel have a great deal to do with excessive sludge in the lubricating oil, due to slow or faulty combustion and cracking of the heavy ends.

Ring Sticking

Viscosity of the circulating oil increases with use due to oxidation. Water should be kept out of circulating systems at all cost. Excessive deposits in piston ring grooves interfere with proper ring functioning. Reduction of the rate of carbon formation can be obtained by keeping piston temperature below the cracking point of the oil and allowing enough lubricating oil to pass to the top ring to flush the blow-by carbon from the ring grooves. Here, again, the high end point of the fuel, which is slow burning and cracks into fine, sooty carbon, and tarry matter, will increase the rate of ring sticking. In a few cases where ring temperature was sufficiently high to crack the lubricating oil, or even where circulating-oil temperatures were extremely high, ring sticking was overcome by additions of small amounts (2% or less) of carbon disintegrator material to the oil. This kept the carbon from building up into a briquette.

In discussion, T. B. Rendel, of Shell Oil Co., brought out that ring sticking is largely a matter of carbon blow-by from the fuel. It is possible for a refiner to make oil that will not oxidize, but this will not dissolve carbon or sludge which may be formed. Thus, it is possible to have gumming of either rings or the crankcase oil passages.

Fuel Problems

Discussion then shifted over to fuel problems. Very fine dust erodes the injection pump. One manufacturer now uses a double system, first causing fuel oil to pass through a fabric filter, then through a felt pack. Mr. Fodor said that sand gets into lubricating oil when the operator changes it. Mr. Larson suggested that proper lubricating oil specifications should include rate of change of viscosity, carbon content, neutralization number and concentration. Asphaltine content should be kept down to 0.25%; when it is above that the oil should be changed. Mr. Baerlein suggested a pre-filter cloth or chamois bag in the fuel-tank inlet to avoid dust in the fuel tank.

S. Rosenzweig, president of Korfund Co., presented "Vibration Control of International-Combustion Engine Installations," a complete discussion of the need for protection against transmission of machine vibration, and outlined laws governing their control. He discussed various isolating materials with their relative advantages and applications in actual use. He pointed out that a material may not be an efficient vibration absorber under all conditions just because it is elastic. There is no cure-all isolator; each job is a problem in itself.

Fuel-oil Research

Friday morning, Dr. A. E. Becker, of Standard Development Co., presented "History and Present Status of Diesel Fuel Oil Research and Specifications," prepared by himself and M. J. Reed of Diesel Engine Manufacturers' Association. After a discussion of development of fuel-oil specifications, the paper brings out that temperature required for ignition of fuels varies markedly with such factors as delay period, air-fuel ratio, atomization and turbulence.

From the angle of engine design and performance the authors feel a satisfactory solution of the ignition quality problem is essential, and that there is a great need for more correlation data between laboratory tests and commercial engine performance. Increased adoption of supercharging, higher compression pressures, and refinements in injection apparatus and combustion chamber design will all no doubt contribute materially to solution of the problem. They point out that so-called "dopes," or chemicals added to a fuel to improve its rating, must also be safe to handle and ship, easy to blend and low in cost. The authors advocate, in conclusion, that low-viscosity fuels are entirely satisfactory for diesels, and also wider study of better methods for preventing contamination of fuels with dirt during storage and handling. They felt that sulphur limits were not important in fuels, and possibly that a more indicative carbon test might be developed as a substitute for the Conradson test.

In discussion, Mr. Goodnow brought out that sulphur running to 4½ or 5% in a fuel was very damaging to injection systems, and that the trouble is caused by a combination of the iron with the sulphur to form iron sulphide. Professor Schweitzer, of Penn State College, felt that pressure should be added to the list of important factors, since he has found that 1/10 in. variation in barometric pressure makes a difference of 2 points in the cetane number of a fuel. Higher pressure gives shorter ignition lag. In blending fuels, he finds that the relation between octane and cetane numbers, is not directly inverse; that is, a dope like ethyl fluid improves octane number much more than it decreases the cetane. A new method developed by Penn State for determining cetane number is eight times faster than previous methods and much less sensitive to normal causes of variation in the bouncing-pin methods.

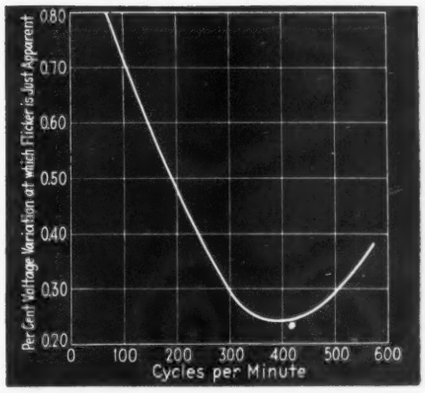


Fig. 2 — Per cent voltage variation causing flicker at various frequencies (average for 115 volt, 60-watt Mazda B and 100-watt Mazda C)

Indications are that Dr. Becker's diesel index is the best index available. In deciding between erosion and corrosion as the cause of wear on engine or fuel pump parts, it was suggested that corrosion usually causes discoloration, while erosion does not, and this serves as a method of distinguishing between them. Mr. Weinberg, of New York Central, said that they have had no trouble with low-sulphur fuels, but with a recent 3% sulphur fuel, all fuel lines in four engines had to be replaced because they had corroded through.

M. J. Reed, of Diesel Engine Manufacturers' Association, then presented the report on Oil Engine Power Costs for 1935. Since the first report in June, 1929, which listed data on 27 plants, and the following one in 1930, which listed data on 36 plants, the report has grown until the latest one presents complete data on 168 plants, including 447 engines, totaling 237,755 hp. One or two minor changes in form have been made, but otherwise the material is similar to that of previous years.

Professor Schweitzer, of Penn State, in his discussion showed lubricating-oil consumption charts based on the 1934 report of costs. This was attacked by a number of engineers present, however, on the basis that it did not consider all factors, including such elements as comparable fuel consumption and comparable maintenance cost. Hermann Lemp of Ingersoll-Rand, pointed out, for example, that it is possible to reduce lubricating-oil consumption to a very economical point, but maintenance costs and fuel costs may rise as a result.

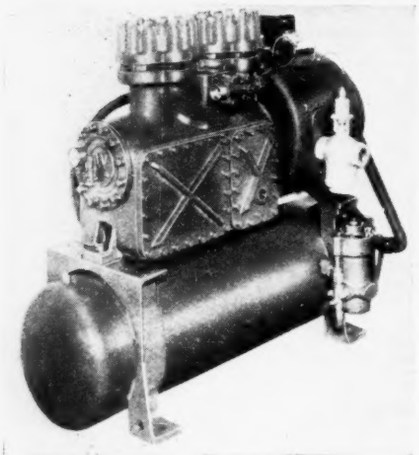
Fuel Injection

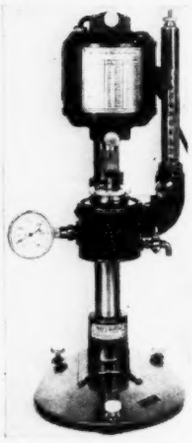
"Characteristics of Fuel-Injection Systems," by C. R. Alden, research engineer of Ex-Cell-O Aircraft & Tool Corp., was an extensive discussion of this company's newer type pumps.

Max Hofmann, of Waukesha Motors Co., explained that automatic advances in connection with increased speed is essential in high-speed engines. Mr. Fisher brought out the importance of timing quantity and injection advance.

Saturday morning, Hans Fischer, of Lanova Corp., presented "Characteristics of the Lanova-Combustion System," a general discussion of the development of the Lanova design and its applications, thus far. The system gives steady idling, lends itself very well to supercharging, is no more sensitive to varying fuel characteristics than others, etc.

WHAT'S NEW IN PLANT EQUIPMENT





AIR-CONDITIONING CONDENSING UNITS

TYPE "CLS" hermetically sealed, air-conditioning condensing units rated at from 7 to 22 tons cooling capacity have water-cooled a.c. motors completely inclosed with compressors and use freon as refrigerant. Rotor of driving motor is overhung from main rear compressor bearing on short extension of compressor crankshaft. Forced lubrication from pump driven from main crankshaft through Micarta gear. Series-parallel condenser manifold permits use of city water or cooling tower.

Entire operating mechanism can be exposed by removing side plates from crankcase casting. Major parts are interchangeable resulting in quick and easy servicing. It is claimed that for equal capacity new unit is smaller and lighter.

Westinghouse Electric & Mfg. Co., Mansfield, Ohio.

PORTABLE UTILITY AIR COMPRESSOR

SELF-CONTAINED, air-cooled gasoline engine-driven compressor can be mounted crosswise on motor truck and leave ample body room for hauling men, equipment and materials. Direct-connected to 4-cyl. 900 r.p.m. Hercules engine to produce 85 c.f.m. at 100 lb. pressure. 7½ in long, 30 in. wide and 50 in. high. Bulletin.

Chicago Pneumatic Tool Co., 6 East 44th St., New York,

VULCANIZER

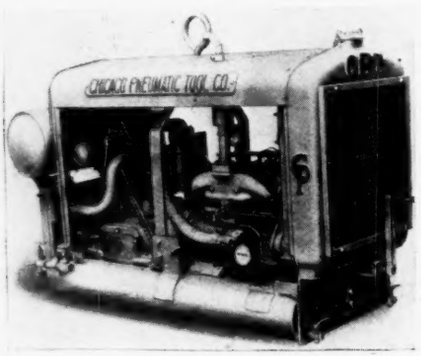
BY USE of aluminum, cost of vulcanizer for belting up to 28-in. reduced and weight lowered to 300 lb. Platen can be handled by one man. Available in 100 and/or 220 volts a.c. and d.c.

Mechanical Rubber Goods Div., B. F. Goodrich Co., Akron.

AUTOMATIC PRESSURE COMPENSATOR

ERRORS due to variation in static pressure while measuring flow of compressible fluids are compensated for by a spiral pressure tube connected to a lever. As line pressure changes, spiral automatically adjusts multiplication of linkage between float and pen arm. At zero flow, pressure changes do not affect position of flow pen; at all other points, shift is just sufficient to compensate for this factor in flow formula. On square-root scales, pen position is varied with change in absolute pressure. On uniform scales, correction in proportional to square-root of change in pressure.

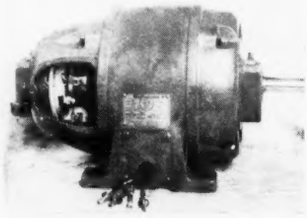
The Foxboro Co., Foxboro, Mass.



GREASE STABILIZER TESTING MACHINE

TO DETERMINE the mechanical stability of heavy lubricants this machine works a definite amount of grease in a plate-shielded size 204 SAE bearing in a grease cup which is free to turn. Bearing is on spindle-extension of constant-speed, 3450 r.p.m. motor. Temperature of grease is controlled and recorded by dial thermometers. Accessories consist of grease-measuring cup, melting point apparatus, and BEC Penetrometer. Bulletin.

Taft-Pierce Mfg. Co., Woonsocket, R. I.



SINGLE-PHASE INDUCTION MOTOR

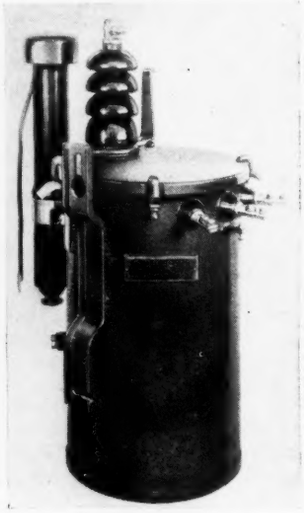
TYPE CR, single-phase, repulsion start, induction motor for general use has high starting and pull-in torques and is made in ¾- to 3-hp. sizes for 110/220 volts on all commercial frequencies. At about 60% of synchronous speed, centrifugal device short circuits armature and motor acts as squirrel-cage induction motor.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

DISTRIBUTION TRANSFORMERS

BUILT for various commercial voltages in sizes from 1½ to 10 kva. these distribution transformers have separately-wound high- and low-voltage coils of circular design. High-voltage winding on sectionalized spool can be slipped off helical low-voltage winding. Can be bolted to pole or hung on conventional hooks. Made with one or two primary bushings and provision for mounting surge diverters.

Allis-Chalmers Mfg. Co., Milwaukee, Wisc.



SMALL BUILDING AIR CONDITIONER

REDESIGNED "Climate Changer" has coated cascade traps and new target - type humidifier which eliminates clogging of spray nozzles. Fine stream of water at high velocity is directed against target and spread in fine mist throughout humidifier chamber. ½-in. thick insulation on bottom of unit prevents sweating. Motor now on side of unit for easy servicing.

Trane Co., La Crosse, Wis.

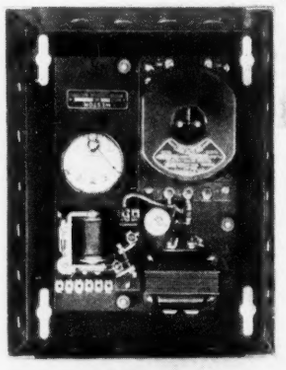


PHOTO-CELL CONTROL UNIT

INDUSTRIAL photoelectric control unit in which sensitivity and operating speed are said to have been doubled, consists of high-output photo-cell in protective mounting and complete relay in separate panel box. Light intensity of 100 ft-candles on cell operates relay with capacity of 500 watts output. Single pole, double-throw relay has over-all speed response of 0.15 sec. Model 729, including photo-cell, relay panel and light sources, will sell for much less than former units.

Weston Electrical Instrument Corp., Newark, N. J.

HIGH-SPEED CIRCUIT BREAKER

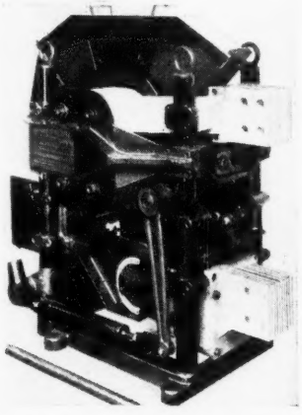
TYPE OH, high-speed circuit breaker has maximum continuous rating of 10,000 amp. at 600 or 1500 volts. Weighs about one ton, with much of weight concentrated in blowout coils and magnetic circuits. Four

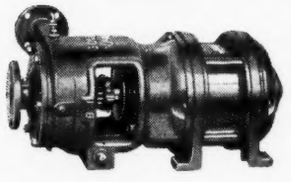
hand-drawn copper contacts covered with blocks of silver are sprung separately to make up moving contact. Current is led into moving contacts through another set of silver blocks on bottom of contact structure, so that current is not carried by flexible conductors. Auxiliary arcing contacts are protected with surfaces of elkonite and arranged so that repulsive force of magnetic field tends to maintain contact pressure until breaker movement separates arcing tips. Opening force of 10,000 lb. produced by two springs in compression, one within the other in a cylinder.

Contacts are held closed by overcenter toggle acting through coupling consisting of interlaced lamination of thin, hard steel and of phosphor bronze. Pressure applied to lamination produces friction which holds pressure of opening spring. Overload causes tripping armature to reduce pressure on laminations which slip apart and springs open breaker.

Overload mechanism responds to plain overload and rate of rise so that breaker trips below calibration setting on short circuit with rapid rate of rise. On test, breaker opened short circuit rising at 9,000,000 amp. per sec. in 0.0063 sec. Bulletin 436.

I-T-E Circuit Breaker Co., 19th & Hamilton Sts., Philadelphia, Pa.





MOTOR-DRIVEN CENTRIFUGAL PUMPS

SMALL, light-weight Fig. 3620 motor-driven, centrifugal pumps are available with standard or special construction for ordinary and corrosive industrial liquids. 15 sizes for from 5 to 1600 g.p.m. All moving parts are on single oversized shaft running in heavy-duty ball bearings. Inclosed, single-suction type impellers with safe motor-load characteristics are keyed and locked to shaft. Casings may be swiveled to four positions and are equipped with priming, drain openings and air-vent cock.

Goulds Pumps, Inc., Seneca Falls, N. Y.

ELECTRIC MARKER

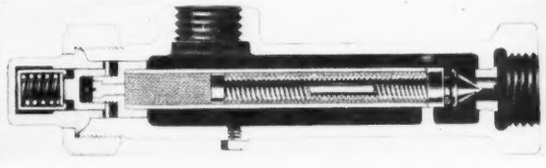
MOTOR-OPERATED, portable electric marker "writes" on metallic and non-metallic materials. Handsize, 6¾ in. long, weighs 2 lb. and is handled as a pencil or crayon. Hardened point cuts into surface to produce permanent lines. Unit supplied with 6-ft. cord with switch and plug for 110 volt, 60 cycle and other standard outlets. Consumes about 75 watts.

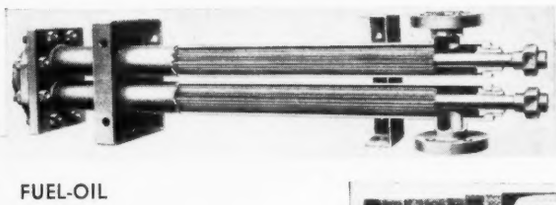
Ideal Commutator Dresser Co., 1025 Park Ave., Sycamore, Ill.

TEMPERATURE CONTROL VALVE

THERMOTON valve, operated by liquid expansion provides low-cost approximate temperature control by automatically varying flow of steam to heating coil or jacket. Actually is an orifice automatically varied in size by position of needle valve which is controlled by temperature of expansible member in turn proportional to volume of steam flowing. Key adjustment for amount of steam fed. Can be used on steam outlets from jackets, chests or coils in place of steam traps. Will discharge condensate at any set temperature down to 90 deg. F.

Sarco Co., Inc., 183 Madison Ave., New York, N. Y.





FUEL-OIL HEATER

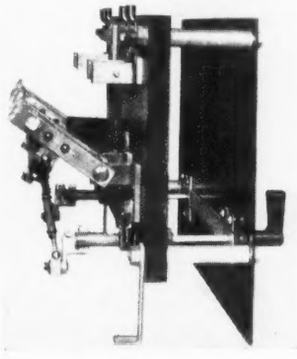
TWIN G-Fin Section fuel oil heater has patented heating elements in which exterior heating surface has more than eight times area of interior cylindrical surface. Two parallel steel pipes with flanged inlet and outlet connections at one end and welded flange at other serve as shells for fin-pipes. 18 longitudinal fins about circumference extend along length of each pipe from shell connection to return bend at floating end where steel ring around fins supports internal pipe in shell. Forged-steel plug with conical face forms metal to metal joint at connection end. At other end, G-Fin pipe forms return bend within forged-steel cover also serving as return connection. Series or parallel. Form 707.

Griscom-Russell Co., 285 Madison Ave., New York, N. Y.

MANUAL FIELD DISCHARGE SWITCH

TYPE LF-23, manually-operated field discharge switch for motor and generator circuits is dead-front, mounted in back of board, and is rated at 250 volts d.c., 100 and 200 amperes only. Double-throw switches are made up of two single-throw switches with mechanical interlock to prevent closing both throws at once. Operating handle and escutcheon are similar to those of Type SB-1 control switch. Tongue-contacts and laminated blades with embossed line-pressure contacts are used.

General Electric Co., Schenectady, N. Y.



AIR HOSE

"HIPRESS" air hose has inner carcass of four plies of specially woven duck and outside of tight braid of high tensile cords. Insulation between inner and outer canvass serves as secondary tube seal and cushion for external blows. Tube is of oil- and heat- resisting rubber while rubber cover is compounded to withstand abrasion and abuse. Three sizes, ½, ¾ and 1 in. in 500-ft. lengths.

Mechanical Rubber Goods Division, B. F. Goodrich Co., Akron, Ohio.

PNEUMATIC TYPE CONTROLLER

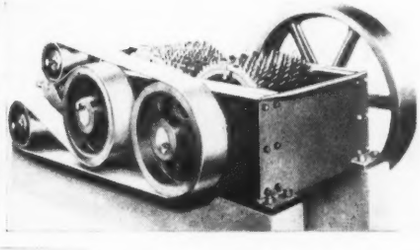
MODEL 90 Controller for automatic temperature and pressure control where chart record is not necessary or is already in use. Same type of precision measuring element used in recorders is utilized in controllers. Has wide-range sensitivity adjustment and can be changed from direct to reverse-acting, or vice versa, without additional parts. Moisture-, fume-, and dust-proof case for wall and flush-panel mounting. Bulletin No. 444.

The Bristol Co., Waterbury, Conn.

VALVES FOR COPPER PIPING

"SOLDER-END" valves for copper lines with up to 150 lb. pressure are available at same price as plain-sweated and Mueller "Streamline" type ends. Except for ends, new valves are same as standard threaded valves. 8-page folder.

Jenkins Bros., 80 White St., New York, N. Y.



DOUBLE-ROLL COAL CRUSHER

SELF-CONTAINED, endless belt drive between rolls of this double roll crusher allow quick adjustment of rolls within limits of sizing range while machine is running. Provided with all-steel frame with heavy steel cross-ties.

Jeffrey Mfg. Co., Columbus, Ohio.

FIRST RIVER CONTROL BY NORRIS DAM

To maintain navigable depth in lower river, 97,000 acre-ft. of water was passed through Norris Dam sluiceways at 5,900 cu. ft. per min. from June 19 to July 3. Lake level fell from the 999.88-ft. peak to 996.15 ft. Gates were closed following heavy rains which broke most severe spring and early summer drought on record in East Tennessee. Drum-types gates in spillway crest at El. 1,020 can raise reserves level another 14 ft. for flood control

3000 EXPECTED TO ATTEND WORLD POWER CONFERENCE

ENGINEERS, scientists and economists throughout the world will focus their attention on Washington, D. C., from Sept. 7 to 12, when most of the leading international authorities on power will meet for the Third World Power Conference and Second Congress on Large Dams. More than 700 distinguished representatives of 48 nations will meet with some 2,500 Americans to consider "The National Power Economy."

Through the cooperation of scientists, industrialists and government representatives of many countries the World Power Conference was originated to solve some of the problems involved in the conservation and use of natural resources. It is a federation of committees of some 50 countries. Two previous plenary meetings have been held, the first in London in 1924, the second in Berlin in 1930. It has also held "sectional meetings" in Basle, London, Barcelona, Tokio and Stockholm.

Under the auspices of the W.P.C. the International Commission on Large Dams was organized and its First Congress held in Scandinavia in 1933.

Most of the social functions and the formal program of the Conference and Congress will be held in Washington, D. C. Joint opening and closing sessions will be held in Constitution Hall; other sessions will be in auditoriums of various government buildings along Constitution Avenue. Official headquarters will be at the Mayflower Hotel where the American National Committee will have its offices.

The program is divided into two distinct parts—the general program of the Washington discussions and the technical program of the study tours. The theme of the former, "The National Power Economy," will be discussed on the physical and statistical basis, and on technical, economic and social trends. Each participating country is to submit a paper on each of the program topics which has any significant bearing on its power problems. These papers will be condensed into "general reports," and printed in four languages. Both papers and reports will be distributed to delegates well in advance of the meeting.

Neither papers nor reports will be read, but the sessions of the Conference and Congress will be devoted exclusively to oral discussion.

Nine study tours have been arranged by the American National Committee, four to be held before the Washington sessions and five afterward. They will permit a detailed examination of the most modern plants, processes and practices in the U. S. At least one day on each of these tours will be devoted to round-table discussion, planned in advance and led by experts. A summary of the tours is as follows:

Pre-conference Tours

Tour I, (a) Coal (b) Gas (c) Oil (d) Internal Combustion Engines. Begins Aug. 31, visits New York, Detroit, Cleveland and Pittsburgh. Ends Sept. 6. Costs $105.

TourII, (a) Dams (b) Hydro Plants and Research (c) Tennessee Valley Authority. Begins Aug. 28, visits New York, Boston, Niagara Falls, Pittsburgh, Zanesville, Ohio and Tennessee Valley. Ends Sept. 6. Costs $152.

Tour III, (a) Steam Power Plants (b) Electrical Equipment (c) Engineering Education and Research (d) Utility Business Management. Begins Aug. 27, visits New York, Schenectady, Chicago, Pittsburgh. Ends Sept. 6. Costs $148.

Tour IV, Railroad Transport. Begins Aug. 28, visits New York, Schenectady, Chicago and Pittsburgh. Ends Sept. 5. Costs $154.

Post-conference Tours

Tour I (a) Coal (b) Gas (c) Oil (d) Internal Combustion Engines. Begins Sept. 14, visits New York, Pittsburgh, Cleveland, Niagara Falls and Philadelphia. Ends Sept. 21. Costs $106.

Tour II (a) Dams (b) Hydro Plants and Research (c) Tennessee Valley Au-

Program of Conference and Congress

MONDAY, SEPTEMBER 7

Conference

Paper No. 4: Organization of the Production, Processing, and Distribution of Coal and Coal Products.

Paper No. 5: Organization of the Production, Refining and Distribution of Petroleum Products.

Joint Opening Session at 8:30 P. M.

TUESDAY, SEPTEMBER 8

Conference

Paper No. 2: Significant Trends in the Development and Utilization of Power Resources.

Paper No. 6: Organization of the Production, Transportation, and Distribution of Natural and Manufactured Gas.

Paper No. 7: Organization of Private Electric and Gas Utilities.

Congress

Question No. 4: Design and Water-Proofing of Shrinkage, Contraction, and Expansion Joints.

Question No. 5: Study of the Facing of Masonry and Concrete Dams.

WEDNESDAY, SEPTEMBER 9

Conference

Paper No. 3: Collection, Compilation, and Publication of Statistics with Particular Reference to International Use.

Paper No. 8: Public Regulation of Private Electric and Gas Utilities.

Paper No. 9: Organization, Financing, and Operation of Publicly Owned Electric and Gas Utilities.

Paper No. 11: Conservation of Coal Resources.

Paper No. 12: Conservation of Petroleum and Natural Gas.

Congress

Question No. 13: Special Cements.

THURSDAY, SEPTEMBER 10

Conference

Paper No. 10: National and Regional Planning and Their Relation to the Conservation of Natural Resources.

Paper No. 13: Planned Utilization of Water Resources.

Paper No. 15: Regional Integration of Electric and Gas Utility Facilities.

Congress

Question No. 6: Geotechnical Studies of Foundation Materials.

Question No. 7: Calculation of the Stability of Earth Dams.

FRIDAY, SEPTEMBER 11

Conference

Paper No. 14: Utilization of Small Water Powers.

Paper No. 16: Rationalization of the Distribution of Electric Energy and of Gas.

Paper No. 17: Rural Electrification.

Congress

Executive Session: International Commission on Large Dams.

SATURDAY, SEPTEMBER 12

Conference

Paper No. 18: National Power and Resources Policies.

Joint Closing Session.

thority. Begins Sept. 14, visits New York, Montreal, Ottawa, Niagara Falls, Pittsburgh, Zanesville and Tennessee Valley. Ends Sept. 24. Costs $170.

Tour III (a) Steam Power Plants (b) Electrical Equipment (c) Engineering Education and Research (c) Utility Business Management. Begins Sept. 15, visits New York, Schenectady, Niagara Falls, Chicago, Pittsburgh and Philadelphia. Ends Sept. 24. Costs $159. At Niagara Falls those taking this tour may attend the two-day technical meeting of the A.S.M.E.

Tour IV, Railroad Transport. Begins Sept. 15, visits New York, Schenectady, Niagara Falls, Chicago, Pittsburgh and Philadelphia, and ends Sept. 22. Costs $144.

Tour V (a) Transcontinental with direct return to New York. Begins Sept. 14; ends Oct. 4. Costs $275.

(b) Transcontinental with TVA stopover on return. Begins Sept. 14, ends Oct. 5. Costs $300.

Exhibits consisting of mounted photographs, charts, working models, relief maps, etc., will form a complete picture of the development of electric power in the U. S.

The main foyer of the National Museum will be used from Aug. 15 to Sept. 15 for exhibits by: Rural Electrification Administration, U. S. Geological Survey, U. S. Bureau of Reclamation, PWA, American Boiler Manufacturers Assn., U. S. Army Eng. Corps, Municipal power plants, National Coal Assn., Federal Power Commission, Gas and Electric Manufacturers Assn., and American Gas Assn.

At the Mayflower Hotel the promenade and adjoining rooms will house exhibits of: U. S. Forest Service, U. S. Bureau of Mines, American Engineering Council, Diesel Engine Mfg. Assn., U. S. Bureau of Reclamation, National Research Council, Chesapeake & Potomac Telephone Co., in cooperation with Tel. & Tel. and TVA.

Besides these exhibits of the WPC., special displays bearing on power will be presented in their own buildings by the following Washington institutions: Carnegie Institute, Chesapeake & Potomac Telephone Co., National Academy of Science, Potomac Electric Power Co., Smithsonian Institute, U. S. Geological Survey, U. S. Bureau of Standards, Washington Gas Light Co.

Arrangements are being made with the principal electrical research laboratories for an exhibit of the latest inventions in photo-electric cells, tubes, etc.

Personal greetings will be extended to all delegates by an Engineers' World Power Conference Committee and members of the staff of American Engineering Council.

POWER LINES

A.S.M.E. Meets In Niagara Falls

A.S.M.E. will hold a two-day technical meeting in Niagara Falls on Thursday and Friday, Sept. 17 and 18, coinciding with the visit of Tour III of the World Power Conference. Papers to be presented at the first Power Session include: "Current Practice and Trends in American Power Plants" by A. G. Christie; "Superposition" by E. H. Krieg; "Power Station design for pressures from 500 to 800 lb. Having Medium-size Units" by James A. Power. The second power session will be devoted to foreign practice. V. F. Escourt will speak on "Design and Operating Problems When Using Gas and Oil-fired Boilers for Standby Steam Electric Stations" at the third session. Two hydraulic sessions will cover laboratory practice, research, and American and Canadian hydroelectric practice.

N.A.P.E. Awards Grimshaw Medals

For outstanding work in the efficient operation of steam engines, National Association of Power Engineers, Greater New York Local No. 1, presented Robert Grimshaw medals to the following at its July 10 meeting: Warren G. Lewis, chief engineer, Hotel New Yorker; H. W. Wilds, chief engineer, New York Bldg.; W. W. Downey, director of engineering, New York Hospital Medical Center; Frank Smart, chief engineer, Beth Israel Hospital; J. B. Cubberly, supervising engineer, Mount Sinai Hospital; J. C. Goodrich, from 1905 to 1913, chief engineeer, Hotel Astor, 1914 to 1929, chief engineer, Montefiore Hospital, now sales engineer, Sand-Banum Co., Inc. On the face of the medal is a diagram of a steam-engine indicator and the name of the donor. The obverse side is inscribed with the name of the recipient and the purpose of the medal. Presentation was made by D. S. Wegg.

The medals were made possible by a gift of Robert Grimshaw, Ridgefield, N. J., one of the founders of the A.S.M.E., and first editor of *Power*, 1884 to 1886. Mr. Grimshaw afterward became a consulting engineer serving the United States, French, New South Wales, Bavarian and Bohemian governments, and was also director of the International Engineering and Trade Syndicate, as well as author of many technical works, including the Locomotive Catechism, Werkstatt Betrieb und Organisation, Procedes Mechaniques Speciaux and many others.

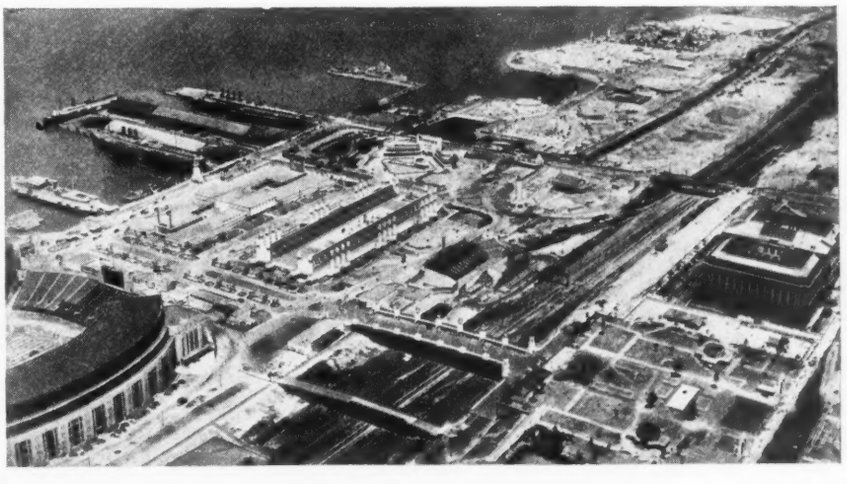
A. S. T. M. Elects A. C. Fieldner President

BEFORE a record-breaking attendance of 1,131, the 39th A.S.T.M. annual meeting, held in Atlantic City, from June 29 to July 3, elected A. C. Fieldner, chief engineer, experiment station division, U. S. Bureau of Mines, Washington, D. C., to succeed H. S. Vassar as president. T. G. Delbridge, manager of research and development dept., Atlantic Refining Co., Philadelphia, was chosen vice-president to serve with Prof. A. E. White, University of Michigan, who became vice-president in 1935.

Three detailed committee reports were presented on coal, coke and gaseous fuels. Committee D-5 on coal and coke, announced a plan to prepare a method of test for dustiness of coal and coke. Results of tests by a number of different laboratories and coal-ash fusibility determined by the Barrett coal-ash fusion furnace and by the gas furnace were said to be sufficiently promising to justify further studies. The committee agreed to recommend to the society a revised method of sampling coal for a rapid reduction of gross samples to a convenient quantity for trans-

$25,000,000 EXPOSITION CITY

Great Lakes Exposition built this city on 150 acres of Cleveland, Ohio, lake front in 90 days at a cost of $25,000,000. Centennial celebration of Cleveland as a city, the exposition will show for 100 days, from June 27 to Oct. 4, what American industries in action look like



mittal to the laboratory. This is accomplished by mechanical methods of crushing and by riffle samples.

Committee D-19 expects to issue, some time during the year, proposed standards for determination of sulphate, hydroxide, total carbon dioxide and total ortho-phosphate iron.

NEWS NOTES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS nominated the following officers for 1937, during the semi-annual meeting at Dallas Texas: For president, J. H. Herron, president, James H. Herron Co., Cleveland, Ohio; for vice-president, J. A. Hall, professor of mechanical engineering, Brown University; J. M. Todd, consulting engineer, New Orleans, La.; R. J. S. Pigott, staff engineer in charge of engineering, Gulf Research & Development Corp., Pittsburgh, Pa. For managers, E. W. Burbank, manager Dallas district, Allis-Chalmers Mfg. Co., K. H. Condit, editor of *American Machinist*, and S. W. Dudley, dean of engineering, Yale University.

"Up-stream" engineering in relation to flood control and land conservation will be discussed at a conference of experts from the U.S. and foreign countries in Washington, Sept. 22 and 23.

ANNUAL Iowa State Convention of N.A.P.E. was attended by over 200 engineers and visitors. C. J. Herbeck, Cedar Rapids, Iowa, was elected president, and Jacob Eige, Marshalltown, Iowa, vice-president. C. A. Bland, Des Moines is secretary, and Chas. Amos, Sioux City, treasurer. The 1937 convention will be held in Cedar Rapids, Iowa.

OBITUARIES

CHRISTIAN PAULSEN BERG, industrial engineer, died July 4. Mr. Berg was associated with Frederick W. Taylor and Carl Barth in their time study and motion analysis surveys. Since 1932 Mr. Berg has been with Link-Belt Co., Chicago.

HENRY GORDON BRINCKERHOFF, 67, dean of New England power equipment salesmen and close personal friend of the late Fred R. Low, died of coronary thrombosis at his home in Cambridge, Mass., July 17. He had for years been a manufacturers' agent and engineer in the six New England states, representing most recently The Engineer Co., Elgin Water Softener Co., Ess Instrument Co., Carling Turbine Blower Co., among others. Mr. Brinckerhoff's grandfather, Dr. Isaac, was a surgeon on "Old Ironsides", his father, Henry Waller, a civil engineer commissioned in the navy by President Grant. He is survived by his wife Alys S., and two sons, H. Winship and Laurence Gordon Brinckerhoff.

WILLIAM H. LARKIN, JR., 65, former power and safety engineer for U. S. Rubber Co., died July 16. Since 1931 Mr. Larkin had been practicing as an independent consultant in Arlington, Mass.

ISAIE GRANGER, 77, engineer in charge of Dominion Government heating plant in Ottawa, Ont., died July 10.

JOHN ELSMAN, 45, chief engineer of the Scribner Building, 311 West 43rd St., New York, N. Y., died July 12 after a protracted illness. As a member of Stevenson Assn. No. 44 (New York), and as special National Deputy, he was very active in N.A.P.E. circles and widely known as a generous and dynamic personality.

HERBERT O. PHILLIPS, 78, former president of Phillips Wire Co., Pawtucket, R. I., died July 13.

GEORGE E. SEABURY, 70, former superintendent of station engineering dept. of Edison Electric Illuminating Co., Boston, Mass., died July 13. Mr. Seabury was connected with Edison Portland Cement Co. in New Jersey early in his career, and later traveled extensively in this country, Europe and Africa for General Electric Co. on power-plant construction work. He was connected with Boston Edison Co. during the time it was constructing the Edgar high-pressure steam station at North Weymouth, Mass.

DANIEL DELANEY, 81, for 35 years Cincinnati manager of Dearborn Chemical Co., Chicago, Ill., died July 3. Mr. Delaney was active in the N.A.P.E. for 50 years, having been a treasurer of the organization at one time. He was a former president of its local group, which recently gave him a gold plaque and the title of "President Emeritus."

LEWIS A. LAWRENCE, 65, for many years production engineer of Green Mountain Power Corp., Montpelier, Vt., died July 12.

PERSONALS

W. W. LEWIS, engineer for General Electric Co., received an honorary Doctor of Science degree from University of Colorado, June 15. Mr. Lewis was honored for his creative work and achievements on lighting, power transmission and high-voltage problems.

CARL LAGER has been elected president of Morris Machine Works, Baldwinsville, N. Y., following the death of President Windsor Morris. PIERCE J. MCAULIFFE is new vice-president and general manager.

A. H. FRAUENTHAL, formerly assistant general manager, has succeeded KARL HERRMANN as vice-president and general manager of Bantam Ball Bearing Co., following Mr. Herrmann's recent resignation.

GEORGE M. SNODGRASS has been appointed general sales manager of Imperial Electric Co., Akron, Ohio.

EDWARD A. LIVINGSTONE has recently been appointed manager of alloy tube sales for Babcock & Wilcox Tube Co., Beaver Falls, Pa.

THOMAS ROBINS, JR., son of the inventor of the troughed belt conveyor, has been elected president of Hewitt Rubber Corp. Others elected were: F. G. Cooban, vice-president, E. K. Twombly, vice-president and treasurer, and J. H. Hayden, secretary.

DEWEY ABELL, chief engineer of production dept., Lawrence (Mass.) Gas & Electric Co. for 30 years, was congratulated recently in an article in "Contact," New England Power Assn. paper, on 50th anniversary of his service with the department.

LEN HARTSILVER recently returned to Vancouver, B. C., from England, where he had been stuyding experiments by F. J. Tippen, inventor, on a new type of diesel engine. Both Mr. Hartsilver and Mr. Tippen are members of Shaw-Stuart, Ltd., Vancouver, B. C.

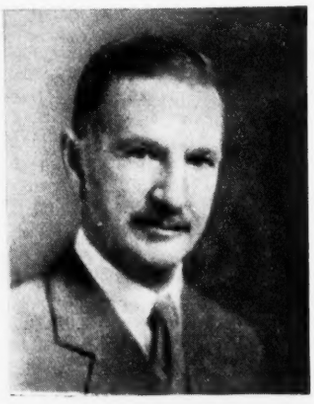
H. C. MCELHONE has been appointed assistant to vice-president of Westinghouse Electric & Mfg. Co.

L. G. WILLCOX has become vice-president of Russell T. Gray, Inc., Chicago, Ill.

EVERETT MORSS, JR., previously vice-president, clerk and secretary of Simplex Wire & Cable Co., Cambridge, Mass., has been elected president and treasurer in place of late Henry A. Morss.

JOHN C. WISE, formerly of New York office, has been appointed manager of new district office at 1149 Union Trust Bldg., Cleveland, Ohio, for Rockbestos Products Corp., New Haven, Conn.

MORRIS E. LEEDS, president of Leeds & Northrup Co., Philadelphia, Pa., has recently received two honors. On June 14 the Institute of Management awarded Mr. Leeds the Henry Laurence Gantt Gold Medal for "distinguished achievement in



industrial management as a service to the community." On June 17 he was made a Doctor of Engineering by the Polytechnic Institute of Brooklyn, "in recognition of great service to society."

STANLEY M. MERCIER, for many years with Jeffrey Manufacturing Co., has joined the sales and engineering staff of Boston Woven Hose & Rubber Co., Boston, Mass.

FOREIGN STRAWS

ROYAL COLUMBIAN HOSPITAL, New Westminster, B.C., has ordered a boiler from Vancouver Iron Works, Vancouver, B.C., following a grant of $10,000 from the provincial government.

HOPE MFG. CO., LTD., 57 York St., London, Ont., plans replacement of present boiler with 100-hp. unit.

CANADIAN CELANESE, LTD., is carrying out a $1,000,000 enlargement. Stewart Construction Co., Ltd., has been awarded contract for boiler house and 800-hp. boiler will be supplied by Babcock-Wilcox, Goldie & McCulloch, Ltd., 606 Cathcart St., Montreal.

MCDOWELL, MANN & LATHAM, LTD., 928 Granville St., Vancouver, B.C., have ordered two 160-hp. Birchfield boilers from Vancouver Engineering Works, Ltd., 519 West Sixth Ave., Vancouver, for the Vancouver City Wall.

Mr. Mercier has been in charge of conveying system at Grand Coulee Dam, Fort Peck, Florida Ship Canal, East Boston, Mass., Harbor Tunnel and many others.

J. C. BLOOMFIELD has joined the shovel, dragline, crane sales division of Link-Belt Co., 300 West Pershing Road, Chicago, Ill. L. B. SPILLAN has been appointed shovel and crane division sales manager and N. A. WESTON has been given charge of shovel division sales in Chicago.

P. K. REED, former president of Atlas Conveyor Co., has been appointed to engineering and sales department of C. O. Bartlett & Snow Co., Cleveland, Ohio.

HENRY F. BAUER, Chester Twelfth Bldg., Cleveland, Ohio, has been appointed sales representative for Bernitz Furnace Appliance Co., Boston, Mass.

DEAN HERMAN SCHNEIDER, University of Cincinnati, was awarded the Lamme Medal for achievement in engineering education at the annual dinner of Society for Promotion of Engineering Education held in the Memorial Union Bldg., University of Wisconsin.

BENJAMIN C. BUGBEE, industrialist and engineer, associated with Cahill & Co., consulting engineers of Milwaukee, Wis., and M. A. Hadcock, of Waukesha, were elected to Board of Directors of Waukesha Motor Co., to fill vacancies left by deaths of H. L. Horning and A. S. Cronk.

EDWIN J. SCHWANHAUSSER, manager of the Buffalo works of Worthington Pump & Machinery Corp., has been elected president of the Buffalo Chamber of Commerce.

CARL W. HANER, former manager of National Utilities Co., at Statesville, N. C., has been appointed manager of the Bluefield Gas & Power Co., succeeding John H. Pritchard, who is to become manager of the Peoples Gas Co., Port Arthur, Texas. All three companies are affiliated under the management of Stone & Webster Eng. Co.

F. E. DUNLAP has been appointed branch manager in charge of conveyor sales and engineering in Michigan, with offices in the Book Tower, Detroit, for Stephens-Adamson Mfg. Co., Aurora, Ill.

JOHN M. CARMODY, now one of three members of the National Labor Relations Board, has been appointed assistant administrator of the Rural Electrification Administration. Mr. Carmody was formerly editor of "Coal Age," and "Factory Management and Maintenance," McGraw-Hill Publishing Co.

CARL J. EBERLY, 2-251 General Motors Bldg., Detroit, Mich., will represent Newark Wire Cloth Co., Newark, N. J.

A. F. RUCKS has been appointed general manager for C. J. Tagliabue Mfg. Co., Brooklyn, N. Y. At the same time W. C. BENNETT was appointed general sales manager in charge of the eastern territory, and E. D. WACKER, general sales manager in charge of the western territory.

DR. JOHN MORRISON FINLAYSON, professor of civil engineering in University of Manitoba, has been elected dean of the faculty of applied science and head of dept. of civil engineering at University of British Columbia, Vancouver, B. C. Dr. Hector J. MacLeod, professor of electrical engineering at University of Alberta, has been appointed head of dept. of mechanical and electrical engineering at University of British Columbia.

H. H. JUDSON, formerly superintendent of Goulds Pumps, Inc., presented the American Exchange paper, "The Founding of Pressure Castings," before the Institute of British Foundrymen, Glasgow, Scotland, June 9 to 12.

BUSINESS NOTES

COVENTRY VICTOR MOTOR CO., Coventry, England, are equipping all models of their gasoline engines to run on paraffin. It is stated that the engines run smoothly on this fuel, usually with an increase in power output up to 10%.

H. W. PORTER & CO., 825 Frelinghuysen Ave., Newark, N. J., appointed the following distributors: Canadian Johns-Manville Co., Ltd., Montreal and Toronto, Canada; Johns-Manville Sales Corp., White Plains, N. Y.; Smith Murray Corp., Rochester, N. Y., and P. S. Thorsen Co. of Mass., South Boston, Mass.

CANADIAN TRIANGLE CONDUIT CO., LTD., has taken out extra-provincial incorporation papers in British Columbia.

GENERAL REFRACTORIES CO., Philadelphia, Pa., have moved their general offices to Real Trust Bldg., Broad and Chestnut Sts.

BRYAN & SIGMON ENG. CO., formerly of Loveland and Cincinnati, Ohio, have opened an office in Newton Falls, Ohio.

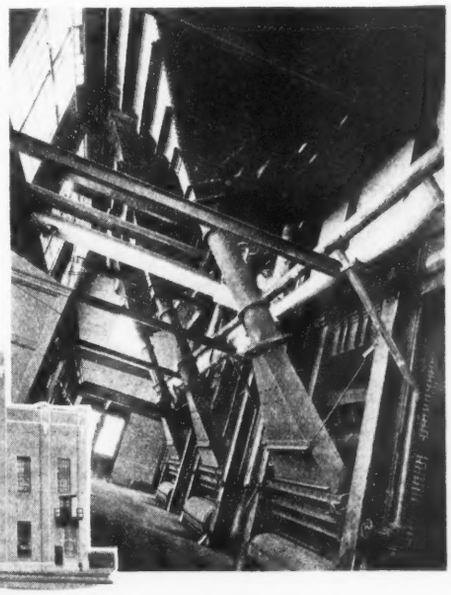
CONNER MFG. CO., Louisville, Ky., has been appointed distributor for northwestern Kentucky by Republic Steel Co., Cleveland, Ohio.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO. will transfer the manufacture of small motors from its Springfield, Mass., plant to Lima, Ohio, where the plant of Relay Motors Corp., has been acquired. Plant will be under direction of R. F. Frenger, manager of small motor division of Westinghouse.

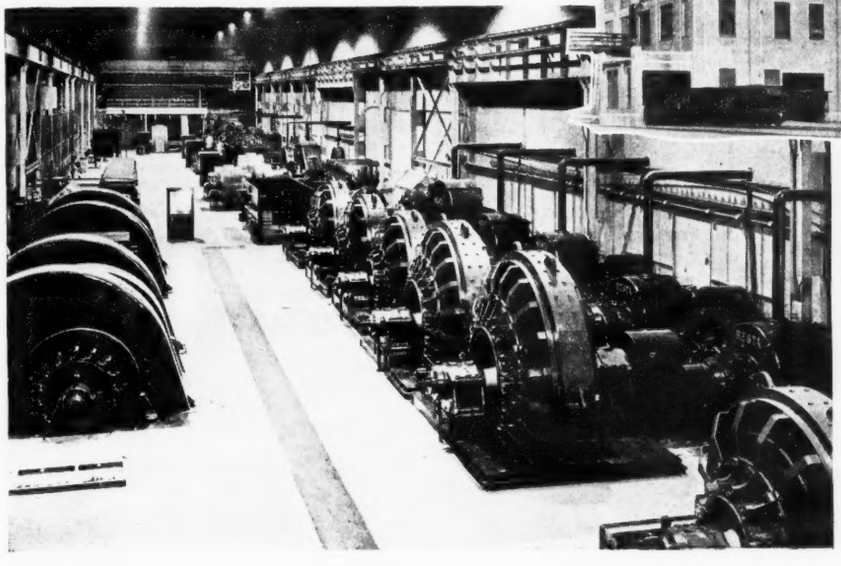
INTERMOUNTAIN BELTING & PACKING CO., 1414 Wazee St., Denver, Colo., will represent Lincoln Electric Co., Cleveland, Ohio, in their state.

CUTLER-HAMMER, INC., Milwaukee, Wis., has moved its Los Angeles sales office to 1331 Santa Fe Ave., Los Angeles, Calif. W. G. Tapping is in charge.

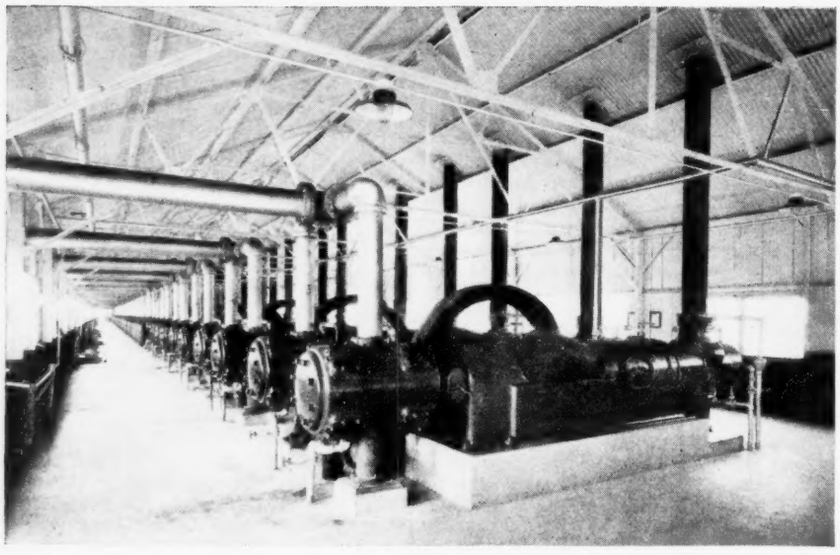
CRANE CO., with offices in Indianapolis, South Bend, Muncie, Terre Haute, Evansville and East Chicago, Ind., have been appointed representatives for American District Steam Co., North Tonawanda, N. Y.



NEW BOILER PLANT FOR BETHLEHEM



Four 5,000-sq.ft. 6-drum water-tube boilers supply process and heating steam at 150 lb. and 200 deg. superheat for Bethlehem Steel Co.'s new sheet-strip mill at Lackawanna, N. Y. Maximum boiler capacity is 200% of rating. Byproduct coke breeze from the plant is conveyed from cars to storage bunkers by an automatic skip hoist, belt conveyor and tripper. Traveling chain-grate stokers are used. The firing floor is 22 ft. above grade, so hopper cars can be run directly under the power-operated, watertight ash gates. Water-treating capacity is 16,000 g.p.h., this equipment, boiler feed pumps and two 2,000-c.f.m. air compressors being housed in the leanto. Condensate is returned to reduce makeup. At left are twelve motors supplying 36,000 hp. to the mill. There are also 1,800 small motors. All power is purchased. Lubricating oil required before operations began would refill an automobile crankcase for 4,600 years.



GAS PUMPS GAS

Thirty 250-hp. Clark direct gas-engine driven compressors boost gas from 10-in. vacuum to 60 lb. per sq.in. in the Phillips-Vinita Park booster plant in the Oklahoma City oil field. Gas is boosted to 750 lb. in a similar station, and used for flowing repressured wells. An oil absorption plant between booster stations takes out the gasoline

STRAWS

Pointing the way business winds blow

PANTORIUM, INC., 2943 Salem Avenue, Dayton, Ohio, floor coverings, plans one-story boiler house and mechanical drying dept. Cost about $30,000, with equipment. Ralph W. Carnahan, Mutual Home Bldg., architect.

JUNEAU (Alaska) COLD STORAGE Co., plans addition to cold storage and refrigerating plant to cost over $60,000.

JACKSON, MINN., contracted Fairbanks-Morse & Co., Chicago, Ill., for diesel unit and accessories for municipal electric plant, at $35,406.

BOARD OF EDUCATION, Toledo, Ohio, plans boiler plant for central heating at vocational high school on Monroe St. Cost $1,700,000. Financing through Federal aid. R. S. Wenzlau, director, Toledo School District, in charge.

BOARD OF PUBLIC WORKS, Memphis, Tenn., plans cold storage and refrigerating plant in public market building, for which $238,000 has been authorized. Henry C. Hibbs, Memphis, architect; Felix O. Beazley, city engineer.

SHELL OIL Co., San Francisco, Calif., contracted Lingren & Swinnerton, Inc., 505 West Olympic Blvd., Los Angeles, Calif., for 10-in welded steel pipeline from Bakersfield, Calif., to Martinez, Calif., about 260 miles. Contracts for 25,000 tons of pipe made with Republic Steel Corp., National Tube Co., Spang, Chalfant & Co., Jones & Laughlin Steel Corp., and A. O. Smith Corp. Cost about $4,500,000. N. W. Thompson, chief engineer.

PURITY BAKING Co., Salt Lake City, Utah, plans steam plant for baking in plant additions. Cost about $250,000, of which over $125,000 will be for equipment. Walter E. Ware, Salt Lake City, architect.

HERNDON, KAN., plans two diesel-generator units, 120-hp., and 60-hp., for municipal electric station. Work to begin soon. Shockley Engrg. Co., Graphic Arts Bldg., Kansas City, Mo., consulting engineer.

STATE BOARD OF EDUCATION, Indianapolis, Ind., plans power house in connection with two dormitory buildings at State School near Fort Wayne.

PURITY ICE Co., Selma, Ala., will make extensions in ice-manufacturing plant, cost about $40,000.

SOUTHINGTON (Conn.) HOSPITAL CORP., Edwin S. Todd, president, plans power house for central heating in new hospital. Cost about $400,000. Lester B. Scheide, Inc., 100 Pearl St., Hartford, architect.

BOARD OF PUBLIC UTILITIES, Kansas City, Kan., contracted Babcock & Wilcox Co., New York, N. Y., for water-tube boiler rated at 150,000 lbs. steam per hour, with auxiliary equipment, at $252,479.

BARRON, WIS., has contracted Fairbanks, Morse & Co., Chicago, Ill., for 1,080-hp. diesel-generator and accessory equipment.

LEXINGTON, KY., plans motor-driven pumping machinery and auxiliary equipment for increased water supply. Cost $3,400,000. Financing through Federal aid. J. S. Watkins, Citizens' Bank Bldg., consulting engineer.

WHITE CLOUD, MICH., has authorized extensions in municipal electric plant, to include diesel-generating unit.

UNION SPRINGS, ALA., contracted J. B. McCrary Co., Atlanta, Ga., for municipal butane gas plant, with pipe line distributing system, at $44,000. R. L. Keenan & Associates, Bell Bldg., Montgomery, Ala.

BUREAU OF PUBLIC ROADS, 515 Fourteenth St., N. W., Washington, D. C., plans steam plant for central heating at research and testing station on George Washington Memorial Highway, Abingdon, Va. Provision will be made for diesel-generator and accessory equipment. Will cost over $750,000. Bids soon.

ANDERSON, IND., has low bid from Westinghouse Electric & Mfg. Co., for turbo-generator and auxiliary equipment for municipal power plant, at $239,825. Five identical bids were received at $58,003 for condenser. Charles Brossman, Chamber of Commerce Bldg., Indianapolis, consulting engineer.

BOARD OF TRUSTEES, University of Kentucky, Lexington, Ky., plans steam power house for central heating. E. B. Farris, engineering dept., assistant engineer.

STATE DEPT. OF FINANCE, Budget and Business, State House, Olympia, Wash., has let contract to Brady Construction Co., Lloyd Bldg., Seattle, Wash., for power house at State Soldiers' Home, Orting, Wash. Cost over $60,000. E. J. Bresemann, Perkins Bldg., Tacoma, Wash., architect.

BOARD OF SEWERAGE COMMISSIONERS, City Hall, Louisville, Ky., will receive bids until Aug. 26 for four motor-driven vertical pumping units and accessories, with capacities from 56,000 to 150,000 g.p.m.

KANSAS PIPE LINE & GAS Co., Topeka, Kan., plans construction of welded steel pipelines to cost over $500,000.

VETERANS, ADMINISTRATION, Washington, D. C., plans power house at multi-unit hospital on Southfield Road, Dearborn, Mich., on 38-acre tract of land donated by Henry Ford. Cost about $1,000,000.

GRAND RAPIDS (Mich.) GAS LIGHT Co., plans welded-steel pipeline from Six Lakes gas field to present line at New Haven, Gratiot County, Mich., about 20 miles. Cost over $150,000.

INDIANAPOLIS (Ind.) RAILWAYS, INC., plans steam power house at car plant on West Washington St. Will cost about $750,000. Bevington-Williams, Inc., Indiana Pythian Bldg., mechanical engineer.

INLAND MFG. Co., Dayton, Ohio, subsidiary of General Motors Corp., Detroit, Mich., plans addition to steam power house. Cost over $125,000. Hillsmith & Co., 108 East Third St., consulting engineer.

ROCKY MOUNTAIN POWER Co., Butte, Mont., is securing renewal of license for hydro plant on Flathead River, near Polson, Mont.

WESTINGHOUSE ELECTRIC & MFG. Co. is constructing a completely air-conditioned warehouse and office building at its Mansfield, Ohio, works. 125 tons of refrigeration furnish conditioned air.

T. & T. BAKERY, 2465 Cornell Ave., Indianapolis, Ind., plans one-story addition to boiler plant and new equipment. D. A. Boehlen & Son, Majestic Bldg., Indianapolis, architects.

FORD MOTOR Co., Dearborn, Mich., approved plans for addition to power plant at River Rouge works, primarily for increased power and distribution facilities in different mill divisions, where demand has reached an all-time peak of 155,000-kw. Expansion will include equipment for handling 265,000-kw., and will cost about $425,000. Other extensions to be carried out soon will include two substations for foundry, where a 325-ft. Westinghouse electric furnace will be installed, with switch-gear and acces-

sory apparatus. Giffels & Vallet, Inc., and L. Rossetti, Marquette Bldg., Detroit, Mich., consulting engineers.

BUREAU OF RECLAMATION, Denver, Colo., will construct 4 drops in All-American Canal in Imperial Valley, Calif., for future hydroelectric developments. Immediate work will cost $1,000,000, with ultimate generating stations to cost over $10,000,000.

VILLISCA, IOWA, contracted Fairbanks, Morse & Co., Chicago, Ill., for two diesel generator units and accessories for municipal power plant, at $136,200. Project will cost about $150,000. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd,. Kansas City, Mo., consulting engineer.

WEST PENN ELECTRIC Co., Pittsburgh, Pa., will install a 25,000-kw. high-pressure superimposed turbo-generator at its Rivesville Station on Monongahela System.

BUREAU OF YARDS AND DOCKS, Navy Dept., Washington, D. C., will receive bids (no closing date stated) for water-tube boiler, oil-burning equipment, draft fans and complete accessories for Naval Operating Base, Norfolk, Va. (Specifications 8195).

KINGSTON, N. C., plans steam plant for central heating. $39,000 is being secured through PWA. To begin work soon.

VAN CAMP SEA FOOD Co., Terminal Island, San Pedro, Los Angeles, Calif., plans one-story boiler plant for factory. William F. Durr, 128½ West Sixth St., San Pedro, architect.

HAMILTON, OHIO, has low bid from Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., for turbo-generator for municipal electric plant at $236,450, and for switch-gear at $14,460. Froehlich & Emery Eng. Co., Second National Bank bldg., Toledo, Ohio, consulting engineer.

CHEVROLET MOTOR Co., Detroit, Mich., plans addition to power plant at Flint, Mich., works. Cost over $75,000, with equipment.

DELTA, COLO., has contracted Fairbanks, Morse & Co., for one 300-hp., and two 225-hp., diesel generator units, with accessories, for municipal electric plant. Awards for miscellaneous equipment will be let soon. Estimated to cost $197,000. Rocky Mountain Eng. Co., Wilda Bldg., Denver, Colo., consulting engineer.

ELECTRA, TEX., plans municipal electric plant, including distributing system. $221,800 has been secured through Federal aid. Work to begin soon.

METROPOLITAN DISTRICT COMMISSION, Water Division, 20 Somerset St.. Boston, Mass., takes bids soon for pumping plant at Belmont, Mass. John M. Gray, 175 High St., Boston, architect.

UNION ELECTRIC LIGHT & POWER Co. has contracted General Electric Co., Schenectady, N. Y., for a 75,000-kw. turbo-generator to operate at 315 lb. pressure and 725 deg. for its Cahokia, Ill., steam plant. The unit is expected to be in operation by Feb. 1, 1938, and will bring the plant capacity to 310,000 kw. Company will award contracts for boilers, stokers, switchboards, etc., later.

EVERETT, WASH., plans steel pipeline for water supply to plant of Soundview Pulp Co., where $2,000,000 expansion will be carried out. Line will comprise 36-in. to 52-in. dia. pipe from Lake Chaplin. $1,300,000 is being arranged through Federal aid. Work to begin soon. S. E. Paine, city engineer and water superintendent.

HOUMA, LA., has contracted Fairbanks, Morse & Co., Chicago, Ill., for diesel generator unit at $64,000 for expansion in municipal power station. Project will cost close to $95,000.

OZARK, ALA., contracted Algernon Blair, Montgomery, Ala., for Butane-air gas plant and pipeline system. Cost $50,000. R. L. Kenan, Bell Bldg., Montgomery, consulting engineer.

BRADY, TEX., has purchased a 1,000-hp. convertible gas-diesel engine as an addition to its municipal plant which now includes a 750-hp. De La Vergne and two 300-hp. Fairbanks-Morse diesels. The new unit is a Worthington 18x25-in. eight-cylinder, four-cycle vertical unit direct-connected to a Westinghouse, 225-r.p.m., 800-kw., 2,300-volt alternator and exciter. It will be equipped with a Woodward governor and will operate as a gas engine. Shipped in July, it is expected to take load early in September. A. M. Lockett, Eng. Co., Dallas, Tex., is engineer.

KANSAS CITY TERMINAL R.R. POWER PLANT, Kansas City, Mo., has recently installed two 46-ton York compressors to provide refrigeration for the terminal building. They are driven by 75-hp. G.E. motors operating on 300-volt a.c. This unusual voltage is stepped down from the station 2,300-volt line.

PARKER CITY, Okla., is planning to add a diesel to its present equipment. Burns & McDonnell, Linwood Blvd., Kansas City, Mo., have begun preliminary surveys.

UNION SULPHUR Co., near Lake Charles, La., is installing a four-cylinder, four-cycle, vertical, 9x11-in., 120-hp., Clark gas engine driving a Gould pump.

OLD GREENBRIER DISTILLERY Co., Greenbrier, Ky., recently organized by J. F. Conway and C. E. Keith, Bardstown, Ky., plans power house at distillery to cost close to $100,000.

OSKOSH, WIS., will receive bids until July 9 for equipment for sewage treatment plant, including gas-engine generators, main sewage and sludge pumps, digesters, screening equipment and other machinery. Robert Cramer & Sons, 647 West Virginia St., Milwaukee, Wis., consulting engineers.

OHIO POWER Co. & WEST PENN ELECTRIC Co., have ordered two 60,000-kw. turbine generators for their Windsor Station at Beach Bottom, W. Va., from General Electric Co., Schenectady, N. Y. The turbines will be the largest, high-pressure, non-condensing, high-temperature units yet built. Generators will be largest to operate at 3,600 r.p.m., as well as largest to be hydrogen-cooled. Designed for 1,250-lb. pressure, 925 deg., and 235 lb. back-pressure, units will be superimposed on existing equipment.

RICHMOND, IND., has begun work on extensions in municipal power plant, including new boiler, automatic stoker, pumping machinery, draft fans and accessory equipment. Cost about $35,000. Fallon & Mills, First National Bank Bldg., engineers.

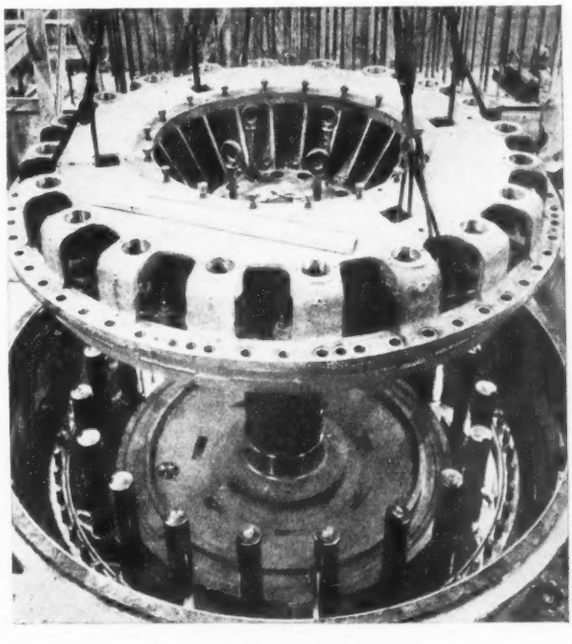
UNION BAG & PAPER Co., Savannah, Ga., has ordered seven duplex vacuum pumps from Roots-Connersville Blower Corp., Connersville, Ind., for suction roll, flat boxes and felt conditioners at its new plant. Five are size 12x18 in., two 10x15 in.

WILLIAMS BROS., Tulsa, Okla., was awarded contract for 178-mi. gasoline transmission line to be built for White Eagle Division of Socony-Vacuum Oil Co. 6-in. welded-steel pipe will run between Augusta, Kans., and Kansas City, Mo.

GREAT LAKES STEEL CORP. has contracted Semet-Solvay Eng. Corp., New York, N. Y., for pipeline to carry blast-furnace gas from Hanna furnaces on Zug Island to Delray plant of Detroit Edison Co. 48-in. welded-steel line will start at Hanna Furnace plant, cross Rouge River, over bridge to be constructed, and run some 2,400 ft. to Edison property.

MERCHANTS EXCHANGE BLDG., San Francisco, Calif., will replace hydraulic elevators with six Westinghouse electric elevators running at 800 f.p.m. from the basement to the fifteenth floor.

NEW MARKET, IOWA, has contracted Fairbanks, Morse & Co., Chicago, Ill., for Diesel generator unit and auxiliary equipment for municipal electric plant, at $53,000. A. S. Harrington, Baum Bldg., Omaha, Neb., consulting engineer.



FOR BOULDER

Placing crown plate on Newport News 55,000-hp. turbine being installed in Arizona wing of Boulder Dam power house. This turbine will connect to a 40,000-kva., 13,800-volt, 60-cycle Allis-Chalmers generator and operate at 237 r.p.m. Six 115,000-hp. units are also being installed

Acme

HOW TO DIE...

A visitor watched an old-time army sergeant drilling a company of soldiers while the lieutenants merely stood and looked on. Asked the visitor of the sergeant, "If you do all the training and handling of the soldiers, what are the lieutenants for?"

"Well," said the sergeant, "when the time comes, they show us how to die!"

The whole idea of dying in just that way isn't all it's cracked up to be, but it does illustrate what I'm thinking about.

In a power plant, the chief engineer compares pretty closely with the lieutenants. If he must watch every little detail, take part in every operation, the chances are that his plant will suffer. If he is a real engineer, he isn't hired to *run* the plant, but to *get results* from it—his subordinates are trained to run it. His job, instead, is to plan ahead, to anticipate needs and troubles and be ready for them. As long as the plant operates smoothly, his men can handle things—the real need for an honest-to-God chief is when things go wrong.

He must know what to do and how to do it for quickest and best results. When the time comes, he "must know how to die."

To do that takes a lot of stick-to-it-iveness. He must forecast; he must keep abreast of progress and development; he must know what he must do to correct a condition if it occurs.

Still more important, he must foresee "trouble" and keep it from happening.

Only by listening, reading, seeing and learning can he do it, only by keeping his mind open to new things, equipment and ideas. Like the captain of a ship, he is "on his own" when storms are brewing; like the captain of a ship, he must be willing to sink or swim with his ship—to show "how to die when the time comes."

George Edwards

GEORGE EDWARDS
Engineer